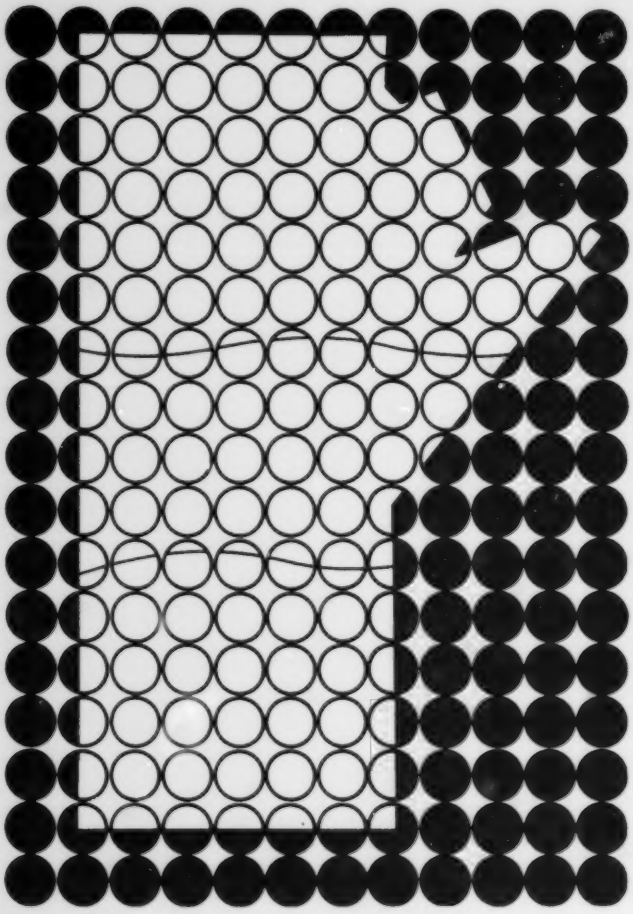


CANADA — MANITOBA
Soil Survey

Soils of the Birtle, Elkhorn, Hamiota, Newdale, Rapid City, Shoal Lake and Strathclair Townsites

Report D65

Government of Canada Gouvernement du Canada
Government of Manitoba Gouvernement du Manitoba

SOILS REPORT NO. D65 1988

SOILS OF THE BIRTLE, ELKHORN, HAMIOTA, NEWDALE, RAPID CITY, SHOAL LAKE AND STRATHCLAIR TOWNSITES

by

GLENN PODOLSKY

CANADA-MANITOBA SOIL SURVEY

AGRICULTURE CANADA

MANITOBA DEPARTMENT OF AGRICULTURE

DEPARTMENT OF SOIL SCIENCE, UNIVERSITY OF MANITOBA

90-02359/

PREFACE

This interim report and map of the detailed field and laboratory study of the soils of the Birtle, Elkhorn, Hamiota, Newdale, Rapid City, Shoal Lake and Strathclair townsite areas is one in a new series of such soil survey reports covering special interest areas in southern Manitoba. These reports reflect the growing concern by various government agencies that support the Canada-Manitoba Soil Survey, that a knowledge of the development and distribution of the soils of Manitoba is the key to understanding their properties, behavior and response to management. This concern requires that soils be described both in terms of their basic properties and the nature of the environmental setting in which they are found. Thus, when an area such as that in the Birtle, Elkhorn, Hamiota, Newdale, Rapid City, Shoal Lake and Strathclair study requires delineation of land of high or low value for crop production or for other uses, the basic reference document is an accurate and reliable soil map.

The land resource information included in this resurvey covers approximately 6 204 ha of land adjacent to the towns. It includes only a fraction of the area covered in the former reconnaissance survey of the Rossburn and Virden Map Sheet Area (Report No. 6, 1956). However, the projected more intensive use of the soils for agriculture and the growing competition for other uses of land in the area has created a need for more up-to-date, more accurate and more detailed soil information. The increased examination of soils in the field, the use of current aerial photography, the use of improved methods of studying soils in the laboratory and the accumulated knowledge of the properties and uses of soils over the years have all contributed to the additional information contained in this new series of reports and maps.

During the course of the resurvey of the project areas, a significant volume of site specific data for the soils mapped in the area was generated, that for practical reasons cannot be included in this interim report. These data are currently being input into the Canada Soil Information (CanSIS) data bank. This computerized system of data management permits automated manipulation and statistical evaluation of large volumes of data for soil characterization and interpretations. These data will shortly be available on request. In addition, the cartographic file of CanSIS provides a capability to produce derived maps of various kinds quickly and inexpensively. The types of derived maps that can be generated from the basic soil map include the sixteen interpretations that are provided in tabular form in this report as well as a number of single feature maps for such characteristics as drainage, texture of surface deposits, slope, stoniness, distribution of salinity, etc. A package of interpretive maps and single feature derivative maps can be made available on request to: The Canada-Manitoba Soil Survey, Dept. of Soil Science, Rm. 362, Ellis Bldg., University of Manitoba, Winnipeg R3T 2N2.

The Canada-Manitoba Soil Survey trusts that this report and accompanying map will be of value to all individuals and agencies involved with the use of land within the map area.

ACKNOWLEDGEMENTS

The study of the Birtle, Elkhorn, Hamiota, Newdale, Rapid City, Shoal Lake and Strathclair townsites was conducted as a joint project of the Manitoba Department of Agriculture and Agriculture Canada in response to a request from the Municipal Planning Branch, Manitoba Department of Municipal Affairs.

Grateful acknowledgement is made to the following persons:

R.E. Smith, Director of the Canada-Manitoba Soil Survey for reviewing the manuscript.

J. Griffiths, R. DePape and M. Brown for compiling, drafting and digitizing the sketches and maps.

D. Sandberg for typing, inputting and assisting in preparation of the report.

R. Mirza, J. Madden, E. St. Jacques and J. Yeung for laboratory analyses, carried out under the supervision of P. Haluschak.

The soils were mapped by G.P. Podolsky, assisted by J. Smiley, J. Mazur and D. Prescott.

HOW TO USE THIS SOIL REPORT

This soils report contains considerable information about the soils, their origin and formation, their classification and their potential for various uses such as dryland agriculture, irrigation, engineering and recreation. The report is divided into four parts: Part I provides a general description of the area; Part 2 describes the methodology used in the study; Part 3 discusses the development, scientific classification and morphological characteristics of the soils in the study area, and Part 4 provides an interpretation of soil properties and associated landscape features as they affect soil capability or suitability for various uses.

The soil map of the study area is compiled on an uncontrolled air photo base which is included in a pocket of the report folder. The map shows the distribution of soil types and associated landscape features that are significant for potential use as field management units. It provides a linkage from landscapes within the study area to the information contained in the report.

To assist the user in retrieving soil information quickly, the following steps are suggested:

If project consists of many individual maps, proceed with STEP 1., if only single map in pocket, proceed with STEP 2 to 6.

STEP 1 Consult the index to map sheets <u>if</u> the report contains many maps. Locate the areas of interest and note the map-sheet number(s) which identify the township and range on each map.

STEP 2 Consult the soil map in pocket of report folder. Locate the area(s) of interest on the map and identify the pertinent map unit symbols. Arabic numerals placed as superscripts following map symbols indicate the approximate proportion of each soil type within the map unit.

STEP 3 Consult the extended legend accompanying the soil map for an alphabetical listing of soil symbols giving the soil name, classification, drainage and related information concerning landforms, nature and depth of materials, and dominant vegetation.

STEP 4 For interpretive information about the soils, consult the appropriate Table in Part 4. Criteria utilized as guidelines in making these interpretations are provided in the Appendix.

STEP 5 Further information concerning the morphological properties and extent of the soils is presented in Part 3 where the soils are described alphabetically according to soil name.

STEP 6 Additional site-specific information not contained in this report is available on request from the Canada-Manitoba Soil Survey, Ellis Building, University of Manitoba.

TABLE 1. SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA
JANUARY, 1988

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Detailed Studies and Surveys								
D1	Pasquia (No. 11)	Pub. 1960	57 200	a,b,d	3	1:63,360	Color	A
D2	Glenlea Research Station	Int. 1963	541	a,b	1	1:7,920	Photo	A
D3	Morden Experimental Farm	Int. 1961	256	a,b	1	1:12,000	Photo	A
D4	Onanole	Pub. 1968	768	a,b	1	1:7,920	Photo	A
D5	York Factory Area	Int. 1969	768	a	3	1:63,360	B&W	U
D6	McCreary Tile Drain Project	Int. 1971	64	a,b	1	1:5,000	B&W	
D7	Brandon Experimental Farm	Int. 1985	768	a,b	1	1:7,920	Photo	A
D8	Portage Potato Farm	Int. 1972	480	a,b	1	1:4,800	Photo	A
D9	Portage la Prairie (No. 17)	Pub. 1972	113 200	a,b,c	2	1:20,000	Photo	A
D10	Morden-Winkler (No. 18)	Pub. 1973	71 424	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D11	Deep Lake	Int. 1975	1 400	a,b	1	1:6,000	B&W	A,I,E,U,R
D12	Thompson Environmental Study	Int. 1976	32	a,b	1	1:1,000	B&W	R
D13	Organic Soil Study of Alexander L.G.D.	Int. 1975	29 456	a,b	3	1:63,360	B&W	A
D14	Winnipeg Region	Pub. 1975	306 000	a,b,c	2	1:20,000	Photo	A,E,U,R
D15	Brandon Region	Pub. 1976	73 250	a,b,c	2	1:20,000	Photo	A,E,U,R
D16	Boissevain-Melita (No. 20)	Pub. 1978	262 912	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D17	Roseau River	Pub. 1977	45 200	a,b	3	1:20,000	B&W	A
D18	Orr Lake	Int. 1977	20	a,b	1	1:1,000	B&W	
D19	Pelican-Rock Lake	Pub. 1983	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D20	West Portage-MacGregor	Pub. 1982	124 866	a,b	2	1:20,000	Photo	A,I,E,R
D21	Minnewasta	Pub. 1978	2 560	a,b	2	1:20,000	Photo	A,E,R,I
D22	Killarney	Pub. 1979	4 600	a,b	2	1:20,000	Photo	A,E,R,I
D23	Matlock-Gimli-Riverton	Pub. 1981	18 400	a,b	2	1:20,000	Photo	A,E,R,I
D24	Glenboro	Pub. 1979	5 960	a,b	2	1:20,000	Photo	A,E,R,I
D25	Sandy Lake	Pub. 1980	1 720	a,b	2	1:20,000	Photo	A,E,R,I
D26	Brokenhead	Pub. 1979	10 813	a,b	2	1:20,000	Photo	A,E,R,I
D27	Rockwood	Pub. 1980	12 928	a,b	2	1:20,000	Photo	A,E,R,I,U
D28	Oak Lake	Pub. 1979	1 293	a,b	2	1:20,000	Photo	A,E,R,I,U
D29	Bird River	Pub. 1980	2 560	a,b	2	1:20,000	Photo	A,I
D30	North Shore Lac du Bonnet	Pub. 1980	2 400	a,b	2	1:20,000	Photo	A,E,R
D31	Grindstone Point	Pub. 1979	8 223	a,b	2	1:20,000	Photo	A,E,R

TABLE 1. SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1988

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
D32	Paint Lake	Int. 1980	2 880	a,b	2	1:10,000	Photo	A,E,R
D33	Cranberry Portage	Int. 1980	80	a,b	1	1:5,000	Photo	A,E,R
D34	Dauphin	Pub. 1981	8 005	a,b	2	1:20,000	Photo	A,E,R,I
D35	South Riding Mtn.	Pre.	23 488	a,b	2	1:20,000	Photo	A,E,R
D36	West Interlake	Pub. 1981	10 036	a,b	2	1:20,000	Photo	A,E,I,R
D37	Swan R. Townsite	Pub. 1987	7 680	a,b	2	1:20,000	Photo	A,E,R,I
D38	Hadashville-organic	Pub. 1981	6 475	a,b	3	1:40,000	Photo	A,E,I,R
D40	Falcon L-Brereton L	Pre.	39 311	a,b	2	1:20,000	Photo	A,E,R
D41	Quesnel Lake-North Shore Winnipeg River	Pre.	6 009	a,b	2	1:20,000	Photo	A,E,R
D42	Duck Mountain	Pub. 1982	3 036	a,b	2	1:20,000	Photo	A,E,R
D43	Spruce Woods	Pre.	26 300	e	3	1:40,000	Photo	A,E,R
D45	Pine Creek	Pub. 1983	1 942	a,b	2	1:20,000	Photo	A,E,R,I
D46	Arborg-Riverton	Pub. 1982	2 590	a,b	2	1:20,000	Photo	A,E,R,I
D47	Roblin	Pub. 1983	4 096	a,b	2	1:20,000	Photo	A,E,R,I
D48	Flin Flon	Pre.	4 600	a,b	2	1:20,000	Photo	A,E,R
D49	St. Anne-La Broquerie, Part of L.D.G. Stuartburn	Pub. 1985	105 280	a,b	3	1:50,000	B&W	A,E,R,I
D50	City of Brandon	Pub. 1984	2 980	a,b	2	1:20,000	Photo	A,E,R,I
D51	Westbourne	Pub. 1985	51,456	a,b	2	1:20,000	Photo	A,E,R,I
D52	Notre Dame, Rathwell, Treherne Townsites	Int. 1984	6 144	a,b	2	1:20,000	Photo	A,E,R,I
D53	Altona, Emerson, Gretna, Ile des Chenes, Landmark, Letellier, Rosenort, St. Jean Townsites	Pub. 1984	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D54	Russell, Binscarth-Townsites	Pub. 1984	3 791	a,b	2	1:20,000	Photo	A,E,R,I
D55	St. Rose Du Lac-Townsite	Pub. 1985	1 536	a,b	2	1:20,000	Photo	A,E,R,I
D56	Souris, Wawanesa, Virden, Townsites	Pub. 1986	6 400	a,b	2	1:20,000	Photo	A,E,R,I
D57	Fraserwood, Inwood, Komarno Townsites, Lake Man. Shoreline	Pub. 1987	1 856	a,b	2	1:20,000	Photo	A,E,R,I
D58	Hallboro, Minnedosa-Townsites	Pub. 1984	4 544	a,b	2	1:20,000	Photo	A,E,R,I
D59	Beaudry Park	Int. 1986	640	a,b	2	1:20,000	Photo	A,E,R
D60	Rural Municipalities of Dufferin, Grey, Roland, Thompson and Stanley	Pre.	325 000	a,b	2	1:20,000	Photo	A,E,R,I
D61	Meditation Lake	Pre.	3 072	a,b	2	1:20,000	Photo	A,E,R
D62	Wanipigow Lake	Pre.	8 960	a,b	2	1:20,000	Photo	A,E,R

TABLE 1. SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1988

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
D63	Shellmouth Resevoir-N	Pub. 1987	4 650	a,b	2	1:20,000	Photo	A,E,R,I
D64	Assiniboine River	Pub. 1987	4 095	a,b	2	1:20,000	Photo	A,E,R,I
D65	Villages of Hamiota, Elkhorn, Strathclair, Rapid City, Newdale, Birtle, Shoal Lake	Pre.	6 204	a,b	2	1:20,000	Photo	A,E,R,I
D66	Benito-Durban	Pre.	18 432	a,b	2	1:20,000	Photo	A,E,R,I
D67	St. Eustache, Springstein, Perimeter Strip, Brunkild, La Salle R.	Pre.	6 200	a,b	2	1:20,000	Photo	A,E,R,I
D68	Spruce Point Mine Area	Pub. 1987	450	a,b	2	1:10,000	Photo	E,R
D69	Snow Lake	Pre.	2 333	A,B	2	1:20,000	Photo	A,E,R,I
D70	Lorne	Pub. 1987	93 240		3,2	1:50,000	B&W,Photo	A,E,R,I
D71	Whitemouth Peatland	Pre.	10 359	a,b	3	1:50,000	Photo	A,E,R,I
D72	Woodlands R.M.	Pre.	9 728	a,b	3	1:50,000	Photo	A,E,R,I
D73	Elk Island-Victoria Beach	Data	2 592	a,b	2	1:20,000	Photo	A,E,R,I
D74	S. Norfolk R.M.	Int.	70 912	a,b	2	1:20,000	Photo	A,E,R,I
D75	Victoria R.M.	Pre.	67 328	a,b	2	1:20,000	Photo	A,E,R,I
D76	Rhineland (con't.)	Data	13 985	a,b	2	1:20,000	Photo	A,E,R,I
D77	Pembina (con't.)	Data	27 972	a,b	3	1:50,000	B&W	A,E,R,I
D78	Springfield*	Data	98 270	a,b	2	1:20,000	Photo	A,E,R,I
D79	Rockwood R.M.*	Pre.	116 550	a,c	4	1:125,000	B&W	A,E,R,I
D80	N. Norfolk R.M.	Data	110 592	a,b	2	1:20,000	Photo	A,E,R,I
*	Upgrade of Data Base							
Reconnaissance Surveys								
R1	South Western (No. 3)	Pub. 1940	709 600	d	3	1:125,000	B&W	A
R2	South Central (No. 4)	Pub. 1943	967 600	d	3	1:125,000	B&W	A
R3	Winnipeg and Morris (No. 5)	Pub. 1953	1 419 200	d	3	1:125,000	Color	A
R4	Rossburn and Virden (No. 6)	Pub. 1956	1 372 400	d	3	1:125,000	Color	A
R5	Carberry (No. 7)	Pub. 1957	967 600	d	3	1:125,000	Color	A
R6	West-Lake (No. 8)	Pub. 1958	592 800	d	3	1:125,000	Color	A
R7	Grandview (No. 9)	Pub. 1957	689 200	d	3	1:125,000	Color	A
R8	Nelson River Basin (No. 10)	Pub. 1973	224 000	b	3	1:100,000	Color	A
R9	Fisher and Teulon (No. 12)	Pub. 1961	949 200	a,c	3	1:100,000	Color	A
R10	Swan River (No. 13)	Pub. 1962	316 000	a,c	3	1:125,000	Color	A
R11	South Eastern (No. 14)	Pub. 1964	749 200	a,c	3	1:125,000	Color	A,F
R12	Lac du Bonnet (No. 15)	Pub. 1967	764 800	a,c	3	1:125,000	Color	A,F,R
R13	Grahamdale (No. 16)	Pub. 1971	764 800	a,b	3	1:125,000	Color	A,F,U,R,E
R14	Red Rose-Washow Bay (No. 19)	Pub. 1975	704 400	a,b	3	1:125,000	Color	A,F
R15	Boissevain-Melita (No. 20)	Pub. 1978	299 520	a,b	2	1:40,000	Photo	A,I,E
R16	Ste. Rose (No. 21)	Pub. 1981	676 705	a,b	3	1:125,000	Color	A,I,R,E,F
R17	Waterhen (No. 23)	Pub. 1985	949 600	a,b	4	1:125,000	B&W	A,I,R,E,F
R18	Swan Lake	Data	599 200	a,b	3,4	1:125,000	B&W	A
R19	The Pas (No. 22)	Pub. 1982	791 700	a,b	4	1:125,000	Color	A,I,E,R,F
R20	Grand Rapids	Pre.	675 031	a,b	4	1:125,000	B&W	A

TABLE 1. SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1988

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
R21	Cormorant	Int. 1975	920 000	a,b	4	1:125,000	B&W	A
R22	Wekusko	Pre.	1 400 000	a,b	4	1:125,000	B&W	A
R23	Pointe du Bois	Pre.	740 000	a,b				
R25	Red Deer Lake	Pub. 1966	34 860	a,b	2	1:31,680	Photo	A
R26	Cross Lake and Norway House	Pre.	615 200	a,b	4	1:125,000	B&W	A
R28	Pasquia Lake	Pub. 1984	2 330	a,b	3	1:50,000	B&W	A,E
R29	Duck Mountain For. Reser.	Data	363 264	a,b,c	4	1:125,000	B&W	A,F,E,R,I

TABLE 1. SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1988

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Biophysical and Exploratory Surveys								
B1	Lake Winnipeg, Churchill & Nelson Rivers	Pub. 1973	3 600 000	e	4	1:250,000 1:50,000	B&W	
B2	Churchill Transportation Corridor	Data 1974	179 000	f	4	1:125,000	B&W	
B3	54C Hayes River	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B4	54D Kettle Rapids	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B5	52M Carrol Lake	Int. 1977	634 000	f	4	1:125,000	B&W	
B5	62P Hecla	Int. 1977	466 200	f	4	1:125,000	B&W	
B6	53D Deer Lake	Int. 1978	629 700	f	4	1:125,000	B&W	
B6	63A Berens River	Int. 1978	848 500	f	4	1:125,000	B&W	
B7	53M Knee Lake	Int. 1978	1 405 900	f	4	1:125,000	B&W	
B8	53L Oxford House	Int. 1978	1 441 100	f	4	1:125,000	B&W	
B8	63H Norway House	Data	540 800	f	4	1:125,000	B&W	
B9	SE 1/4 64A Split Lake	Int. 1979	342 400	f	4	1:125,000	B&W	
B9	63P Sipiwesk	Int. 1979	1 405 900	f	4	1:125,000	B&W	
B10	53E Island Lake	Pre.	1 286 900	f	4	1:125,000	B&W	
B11	63H Norway House	Data				1:125,000	MSS	
E1	Surface Deposits & Soils of Northern Manitoba	Int. 1963		g	5	1:1,267,000	B&W	
E2	Exploratory Terrain Study of Northern Manitoba and Southern Keewatin, N.W.T.	Int. 1974		g	5	1:1,000,000	B&W	

1. Report Status
   Pub.-Published Report and Map
   Int.-Interim Report and Map Available
   Pre.-Preliminary Map and Legend Available
   Data-Field Data Available Only

2. Map Unit Descriptions Code
   a-single series and phases
   b-series complexes defined as to proportion
   c-series complexes undefined as to proportion
   d-associations
   e-biophysical units (materials and physiography)
   f-biophysical units (associations & complexes of associations)
   g-regional and local physiographic units

TABLE 1.

3.Survey Intensity Levels

Code	Name	Scale	Minimum Size Delineation(ha)	Inspection Density (Approx. range)
1	Very detailed	>1:12,000	<1.5	>1 per 3 ha
2	Detailed	1:12,000 to 1:40,000	1.5-16	1 per 3 to 50 ha
3	Semi-detailed	1:40,000 to 1:125,000	16 to 256	1 per 10 to 1 000 ha
4	Reconnaissance	1:125,000 to 1:250,000	256 to 625	1 per 100 to 110 000 ha
5	Exploratory	1:250,000 to 1:1,000,000	625 to 110 000	1 per 300 to 500 000 ha

4.Published Map Base Code

Photo-Photomosaic
B&W -Black and white line
Color-Colored line

5.Interpretations Code

A-Agriculture Capability
E-Engineering
F-Forestry
I-Irrigation Suitability
U-Urban Planning and Community Development
R-Recreation

TOTAL HECTARAGE COVERED

	1987	To Date
Initial Reconnaissance	129,984	19,258,210
Initial Detailed survey	779	18,793
Detailed Resurvey	88.576	3,283,465
Biophysical Survey	---	12,521,000

Published Reports, Maps, Interim Reports, available at a cost of $2.00 per copy (except for D20) from:

Queen's Printer,
Publications Branch,
Manitoba Archives Bldg.,
200 Vaughan St.,
Winnipeg, Manitoba R3C 1T5
Phone:945-3103

Detailed Surveys of Winnipeg Region and Brandon Region available at a cost of $6.00 each from:

Municipal Planning Branch
Manitoba Dept. of Municipal Affairs
1418-405 Broadway Ave.,
Winnipeg, Man., R3C 3L6
Phone: 945-2150

Biophysical Land Classification Maps and Reports available at a cost of $3.50 each from:

Surveys and Mapping Branch
Century Industrial Branch
989 Century Plaza
Winnipeg, Man., R3H OW4
Phone: 945-6666

Preliminary Map and other field data available from:

Canada-Manitoba Soil Survey Office,
Rm. 362 Ellis Bldg., University of Manitoba
Winnipeg, Man., R3T 2N2
Phone: 474-6115 or 474-6118

CONTENTS

PREFACE ii

ACKNOWLEDGEMENTS iii

HOW TO USE THIS SOIL REPORT iv

PART page

1. GENERAL DESCRIPTION OF THE STUDY AREA 1

Location and Extent 1
Land Use 1
Geology 2
Relief and Drainage 5
Physiography 5
Surface Deposits 5
Climate 6
Vegetation 7

2. METHODOLOGY 17

Mapping 17
Map Units 17
Simple and Compound Map Units 18
Phases 19
Sampling 20

3. FORMATION, CLASSIFICATION AND MORPHOLOGY OF SOILS 21

Soil Development 21
Description of Soil Series 22
Angusville Series (ANL) 27
Basker Series (BKR) 27
Beresford Series (BSF) 27
Capell Series (CXT) 28
Carvey Series (CAV) 28
Chater Series (CXW) 29
Clementi Series (CLN) 29
Cobfield Series (CBF) 29
Cordova Series (CVA) 30
Croyon Series (CYN) 30
Croyon Series, shaly gravel substrate variant (CYN1) 31
Dorset Series (DOT) 31
Drokan Series (DRO) 31
Druxman Series (DXM) 32

Eroded Slope Complex (ERX) 32
Jaymar (JAY) 33
Levine Series (LEI) 33
Marringhurst Series (MRH) 33
Marsden Series (MDN) 34
Marsh Complex (MHC) 34
Melland Series (MXT) 34
Miniota Series (MXI) 35
Newdale Series (NDL) 35
Penrith Series (PEN) 36
Rufford Series (RUF) 36
Varcoe Series (VRC) 36
Vodroff Series (VFF) 37

4. USE AND MANAGEMENT INTERPRETATIONS OF SOILS 38

Introduction 38
Soil Capability for Agriculture 38
Dryland Agriculture 38
Irrigation Suitability 44
Soil Suitability for Selected Engineering Uses 50
Definition of Soil Suitability Classes 50
Soil Suitability Subclasses 51
Guides for Assessing Soil Suitability 51
Soil Suitability for Selected Recreation Uses 52

Appendix page

A. CORRELATION OF THE SOILS IN THE STUDY AREA RESURVEY WITH THE SOILS OF THE "RECONNAISSANCE SOIL SURVEY OF THE ROSSBURN AND VIRDEN MAP SHEET AREAS" REPORT NO. 6, 1956. 65

B. GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES 70

C. GLOSSARY 86

D. SOIL HORIZON DESIGNATIONS 101

ORGANIC HORIZONS 101
MASTER MINERAL HORIZONS 102
LOWER-CASE SUFFIXES 102

E. DESCRIPTION OF LANDFORMS 108

GENETIC MATERIALS 108
Unconsolidated mineral component 108
Qualifying Descriptors 109
Organic component 109
GENETIC MATERIAL MODIFIERS 110
Particle size classes for unconsolidated mineral materials . . 110
Fiber classes for organic materials 111
SURFACE EXPRESSION 111
Consolidated and Unconsolidated mineral surface classes 111

Organic surface classes 112

F. NEWDALE PROFILE **113**

G. LEGEND AND SYMBOLOGY **114**

LIST OF TABLES

Table		page
1.	Summary of Survey Coverage for Manitoba	vi
2.	Soil Series of the Study Area Arranged in Relation to Soil Moisture Class, Subgroup and Parent Material	23
3.	Key to the Soils in the Study Area	24
4.	Agricultural Capability Subclass Limitations	42
5.	Agricultural Interpretations of Soils in the Study Area	46
6.	Codes utilized to identify limitations in evaluating soil suitability for selected Engineering and Recreational Uses(Tables 8 and 9)	53
7.	Engineering Description of the Soils and Their Estimated Properties Significant to Engineering	54
8.	Suitability Ratings and Limitations for Soils in the Study Area for Selected Engineering Uses	56
9.	Suitability Ratings and Limitations of Soils in the Study Area for Various Recreational Uses	61
10.	Correlation of Soil Series in the Study Area with Soil Associations and Associates of the Rossburn and Virden Map Sheet Areas, Report No. 6, 1956.	67
11.	Land Classification Standards for Irrigation Suitability	71
12.	Guide for assessing soil suitability as source of topsoil	72
13.	Guide for assessing soil suitability as source of sand and gravel	73
14.	Guide for assessing soil suitability as source of roadfill	74
15.	Guide for assessing soil suitability for permanent buildings	75
16.	Guide for assessing soil suitability for local roads and streets	76
17.	Guide for assessing soil suitability for trench type sanitary landfills	77

18. Guide for assessing soil suitability for area-type sanitary landfills 78

19. Guide for assessing soil suitability as cover material for area-type sanitary landfills 79

20. Guide for assessing soil suitability for reservoirs and sewage lagoons 80

21. Guide for assessing soil suitability for septic tank absorption fields 81

22. Guide for assessing soil suitability for playgrounds 82

23. Guide for assessing soil suitability for picnic areas 83

24. Guide for assessing soil suitability for camp areas 84

25. Guide for assessing soil suitability for paths and trails 85

LIST OF FIGURES

Figure page

1. Location of Study Areas 3

2. Geology of Study Area 4

3. Relief and Drainage Maps 8

4. Physiographic Regions of the Study Area 15

5. Ecoclimatic Regions of the Study Area 16

6. Family particle-size classes 100

7. Soil Textural Classes 100

PART 1

GENERAL DESCRIPTION OF THE STUDY AREA

1.1 LOCATION AND EXTENT

The seven townsites of the study area occur in western Manitoba, to the northwest of Brandon and encompass an area of 6 204 ha adjacent to the towns of Birtle in the R.M. of Birtle, Elkhorn in the R.M. of Wallace, Hamiota in the R.M. of Hamiota, Newdale in the R.M. of Harrison, Rapid City in the R.M. of Saskatchewan, Shoal Lake in the R.M. of Shoal Lake and Strathclair in the R.M. of Strathclair (Figure 1).

This study is a detailed resurvey of portions of the area formerly covered in the reconnaissance soil survey of the Rossburn and Virden Map Sheet Areas (Report No. 6, 1956). The current resurvey was carried out at a scale of 1:20,000 as opposed to the former reconnaissance survey at 1:125,000. A summary of the soil survey coverage for Manitoba is provided in Table 1.

1.2 LAND USE

In spite of the fact that the study is spread over a fairly large area, the land use remains relatively uniform. Agriculture is dominant with the towns providing the essential services and facilities necessary to support the local population.

Agriculture is devoted to a variety of crops including cereal grains, flax and rapeseed. In addition mixed farming, beef cattle, hogs, poultry and dairying are important sources of income with many operations.

The towns in the study are largely agricultural trade and service centres which supply most of the essential services including shopping centres, schools, agriculture supplies, banks, campgrounds, hospitals, service stations and recreational facilities. The Manitoba Antique Automobile Museum at Elkhorn has grown to be a major tourist attraction. Shoal Lake offers a wide range of aquatic recreation as do Birtle and Rapid City to a lesser extent.

Numerous other typical and notable land use requirements closely associated with community activities and growth around the townsites include landfills, lagoons, dikes, dams, hydro electic stations, golf courses, storage areas, parks, roads, railways and highways.

The pothole areas of the study are high density waterfowl breeding grounds which are frequented by hunters during the fall hunting season.

1.3 GEOLOGY

The area covered by the study is underlain entirely by Cretaceous shales of the Riding Mountain formation. More specifically, the Birtle, Hamiota and Rapid City areas are largely represented by soft greenish bentonitic shales of the Millwood Member whereas Elkhorn, Shoal Lake, Strathclair and Newdale are over hard grey siliceous shales of the Odanah Member. The surface deposits of the area reflect a significant proportion of shale in their composition. The present approximate location of the contacts between the formation with the overlying surface deposits is shown in Figure 2.

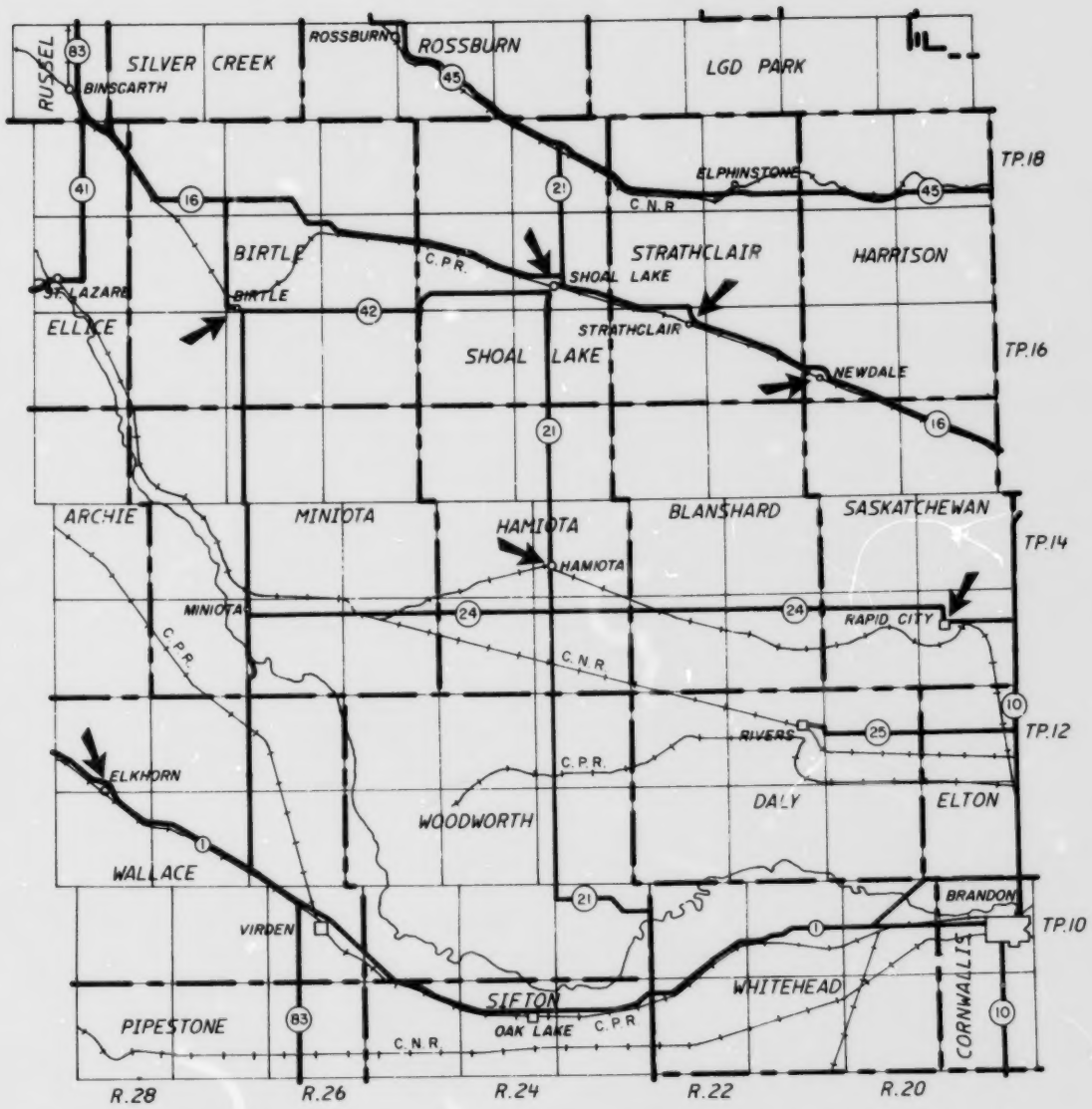


Figure 1: Location of Study Area.

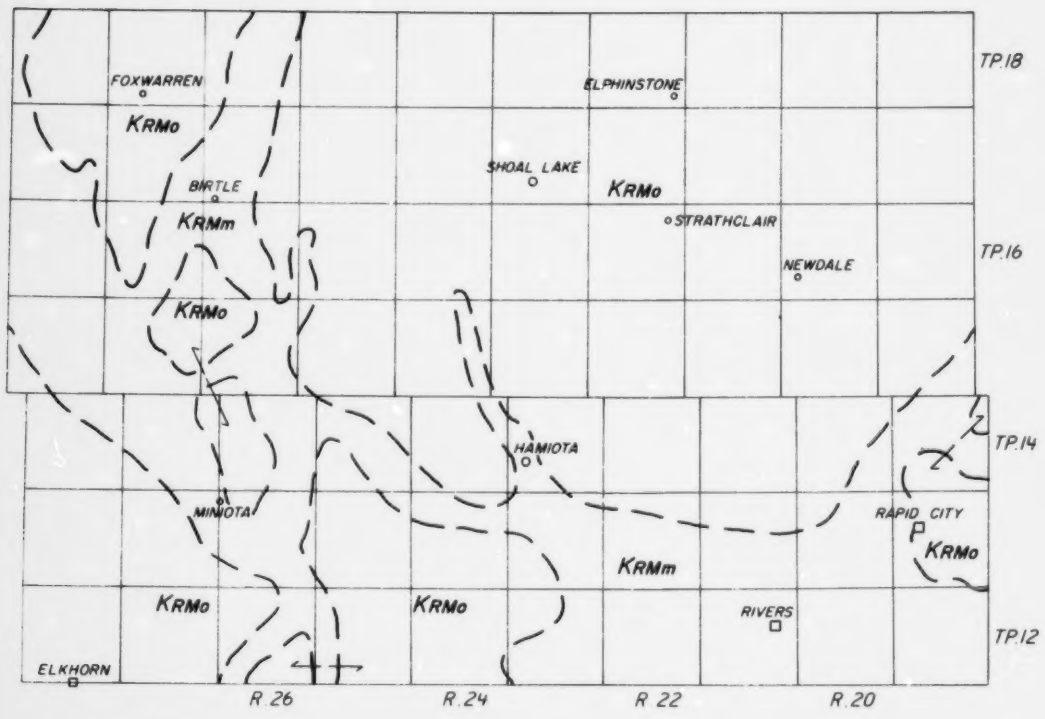


Figure 2: Geology of Study Area.

1.4 RELIEF AND DRAINAGE

The principal relief and drainage features of the study area are shown in Figure(s) 3. The elevation of the study area ranges from approximately 1575 f.a.s.l. (480 m) to 2000 f.a.s.l. (610 m), with the lowest elevations being in the valley bottoms at Birtle and Rapid City and the highest at Newdale. From the areas of Newdale, Strathclair and Shoal Lake the land has a general inclination downward in a south-southwesterly direction toward the valley of the Assiniboine River. The topography is generally undulating with innumerable undrained depressions varying in size from small potholes and sloughs to large meadows and intermittent shallow lakes. Variation from the typical ground morainic type of topography occurs along the river valleys where the greatest change in elevation and landscape exists.

The entire study lies within the watershed of the Assiniboine River system. The Birtle section is drained by the Birdtail Creek, while Rapid City empties into the Little Saskatchewan (Minnedosa) River. Bosshill Creek accommodates drainage of the Elkhorn area. The surface drainage at the other townsites is not as well defined, however it is facilitated largely by numerous drains, ditches and creeks contributory to the Oak River. As a result of the irregular relief pattern, "knob and kettle" type features, surface drainage is quite variable and ranges from excessive runoff on the steeper slopes to prolonged inundation of the depressed areas. The removal of water from many of the local catchbasins is largely through evaporation and seepage.

1.5 PHYSIOGRAPHY

The distribution of physiographic divisions over the study area is outlined in Figure 4. The entire study is within the Assiniboine River Plain section of the Saskatchewan Plain, division.

The major portion of the study is included in the Newdale Plain subsection which is characterized by an undulating to hummocky ground moraine with numerous potholes, sloughs and intermittent lakes. An exception is the Rapid City area which belongs to the Brandon Lakes Plain subsection. This landform is distinguished by a glaciofluvial plain, an undulating lacustrine terrace and a U shaped meltwater channel with dissected valley sides. The undulating moraine which represents the Elkhorn area is within the Pipestone Plain subsection.

1.6 SURFACE DEPOSITS

The most extensive deposits in the study areas is that of the Newdale glacial till. It is a heterogeneous mixture of boulders, cobbles, gravel, sand, silt and clay of glacial origin, with the mixed materials derived from shale, limestone and granitic fragments. The ground moraine is characterized by a succession of low knolls and numerous sloughs or potholes and is dominantly loam to clay loam in texture. Very similar till deposits occur in the Elkhorn area, however they were originally mapped as the Oxbow soils. The distinction from the Newdale soils was based on a slight difference in soil climate. Although stones are present in the study areas, they do not constitute a serious problem to cultivation over most of the area except along the major rivers and creeks. Calcareous and saline phases of soils occur in many poor to imperfectly drained

sites and were mapped extensively at Shoal Lake, Elkhorn and Newdale.

Secondary to the major till deposits are the glacio-fluvial materials that occur at Rapid City, Elkhorn and Birtle. Originally these soils were referred to as the Newdale or Oxbow modified phase, and Benchlands Complex largely due to the sorting and washing of the till by the major rapidly flowing glacial streams. The stream eroded till along the Minnedosa and Birdtail rivers of the study is generally very stony. Stony and gravelly erosion layers of varying thickness, may occur either on the surface or under a thin surface cover where subsequent deposition has occured. The surface texture ranges from loam to clay loam and the subsoil may be stony till, a mixture of gravel and till or only a slightly modified till. In addition a number of deep sand and gravel areas were also delineated.

Alluvial deposition occurs at Birtle and Rapid City adjacent to the Birdtail and Minnedosa Rivers. These post glacial deposits are immature, stratified soils ranging from loam to silty clay loam in texture. The bottomlands may include a small percentage of mucks, peats and marshes.

1.7 CLIMATE

In relation to worldwide climatic conditions, the study area is within the region designated as Dfb[1], subhumid, cool continental. Due to its location in the center of the continent, away from the moderating effect of the oceans, summer temperatures are higher and winter temperatures are cooler than the world average for the same latitude.

Within Manitoba[2] the entire study area is considered to be in the Grassland-Transition Ecoclimatic Region, subregion 2 (Gt_2) as shown in Figure 5. The average annual air temperature for this area is 1.6°C with 111 frost free days. The average annual precipitation is 490 mm. The soil climate is described as having a cool, Boreal temperature class with a subhumid moisture subclass. The mean annual soil temperature ranges between 5.5 and 8.0°C at a depth of 50 cm.

Site specific climatic data from a station at Hamiota[3] indicates an average annual temperature of 1.6°C, with July and August being the warmest months at 18.7 and 17.4°C respectively. The average length of frost free period at Hamiota, based on 1951-80 records is 110 days. The precipitation records show a total annual precipitation of 426. mm and 509. mm at Hamiota and Birtle respectively, with June and July being the wettest months.

---

[1] Koppen, W. and Geiger, "Handbuck der Klimatologie", Bond L., Teil C., Gebruder Borntraeger, Berlin 1936.

[2] Ecoclimatic Regions of Manitoba. Canada-Manitoba Soil Survey, Unpublished Data.

[3] Canadian Climate Normals, Volume 2 and 3. Temperature and Precipitation, 1951-1980. Environment Canada, 1982.

1.8 VEGETATION

The area covered by the study is entirely within the Aspen-Oak Section of the Boreal Forest Region of Canada as delineated by Rowe[4]. Although there are indications that originally the prevailing vegetation was tall prairie grasses, woodland invasion during relatively recent times has produced a park-like aspect to the area. The influence of woods, together with a higher precipitation effectivity due to a slightly cooler climate than areas to the south, have resulted in the soils showing evidence of slightly greater eluviation.

Trembling aspen is the prevalent tree species occuring as small patches or continuous good growth stands around depressions or locally humid positions. Bur oak is conspicuous along river slopes and on drier positions but in general has a sporadic distribution. Other species common to the river channels and valley walls include elm, ash, birch, maple, poplar and willow. Most of the poorly drained areas retain their native cover of willow, swamp birch, meadow grasses, reeds and sedges.

---

[4] Rowe, J.S. 1972. "Forest Regions of Canada". Department of the Environment, Canadian Forestry Service, Pub. No. 1300.

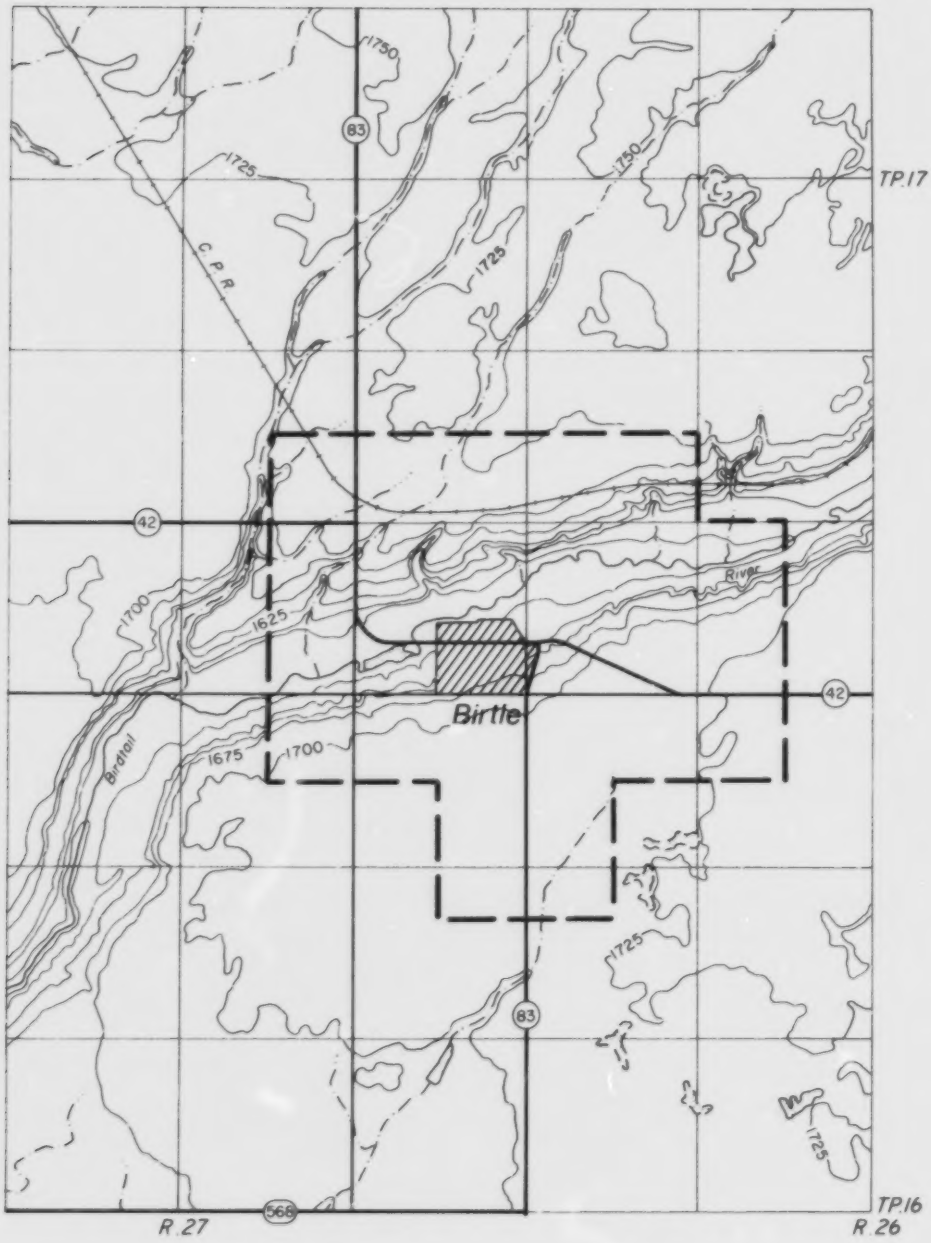


Figure 3a: Relief and Drainage Map of the Birtle Townsite

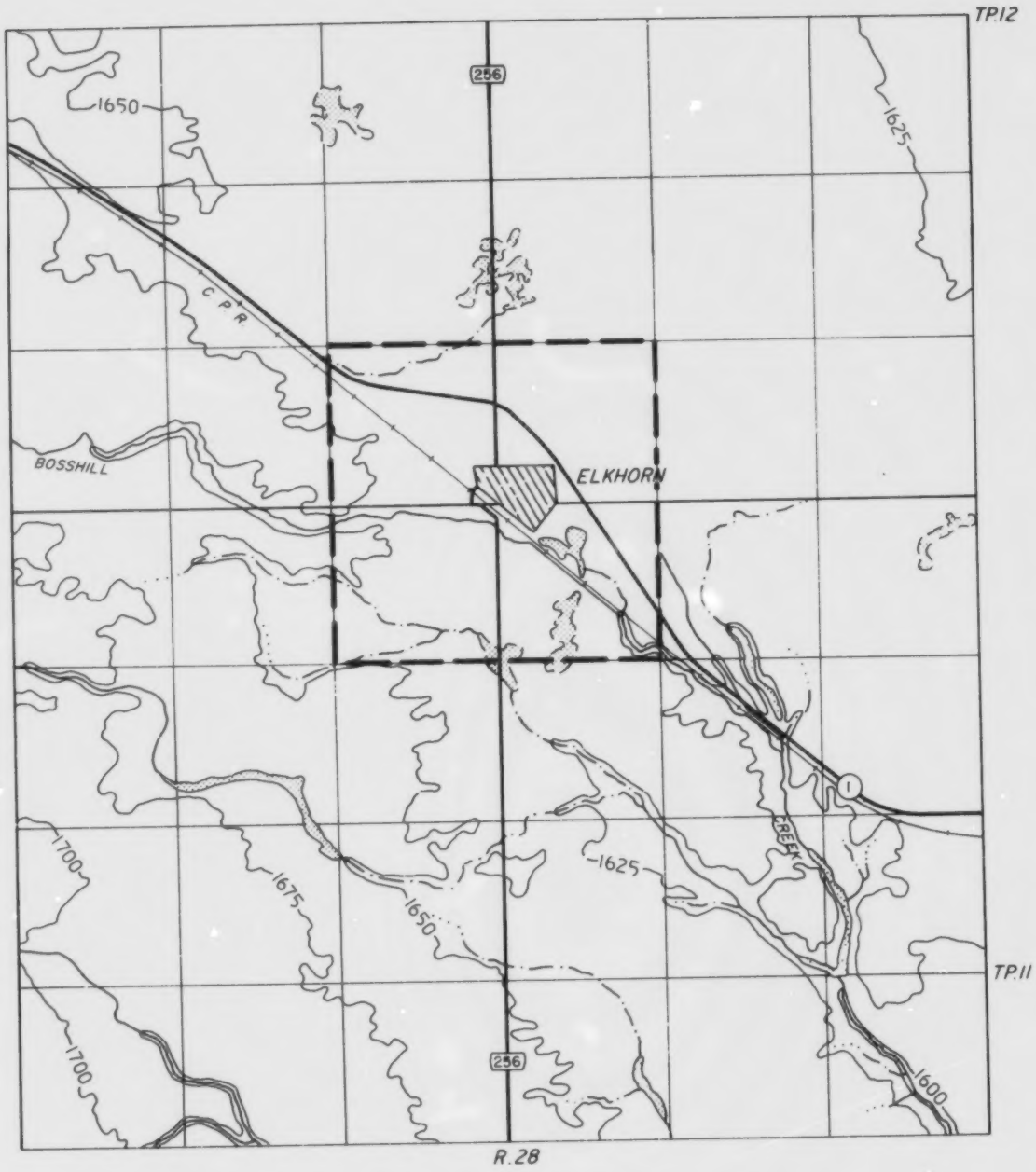


Figure 3b: Relief and Drainage Map of the Elkhorn Townsite.

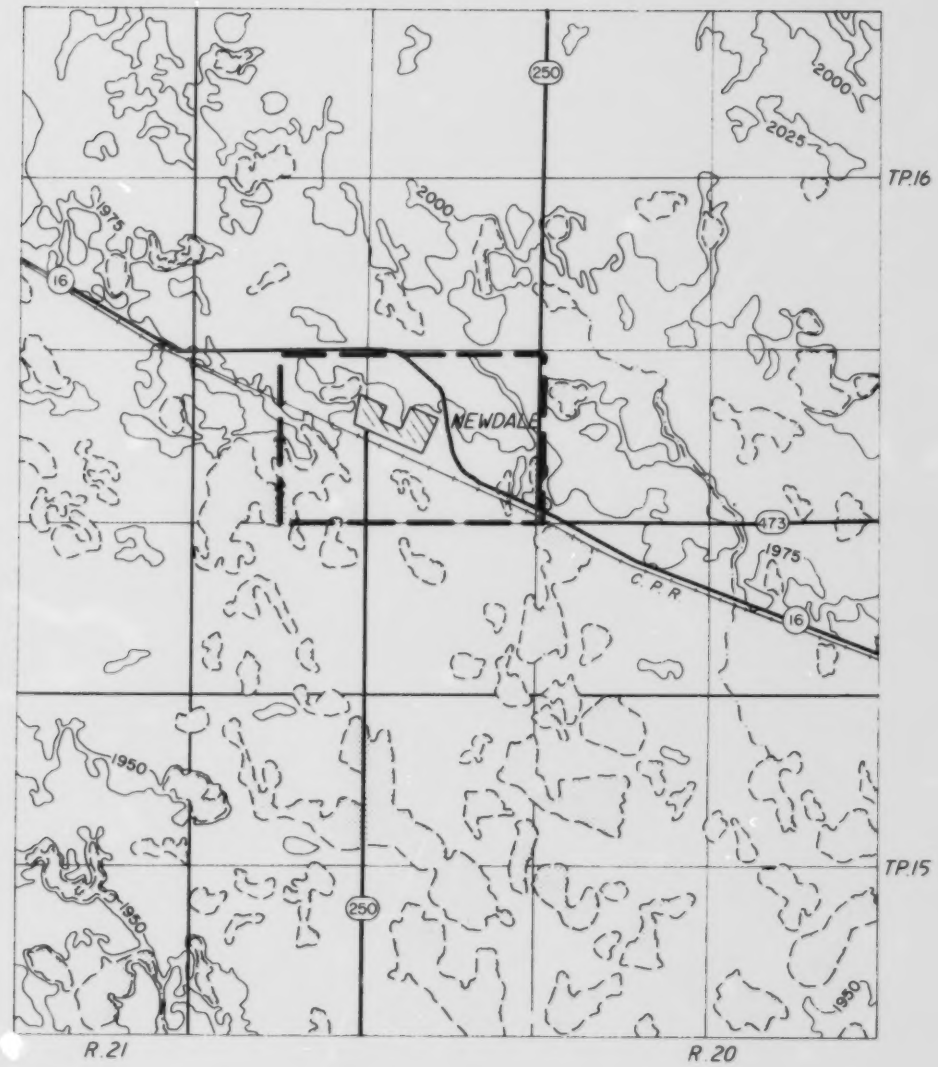


Figure 3c: Relief and Drainage Map of the Newdale Townsite.

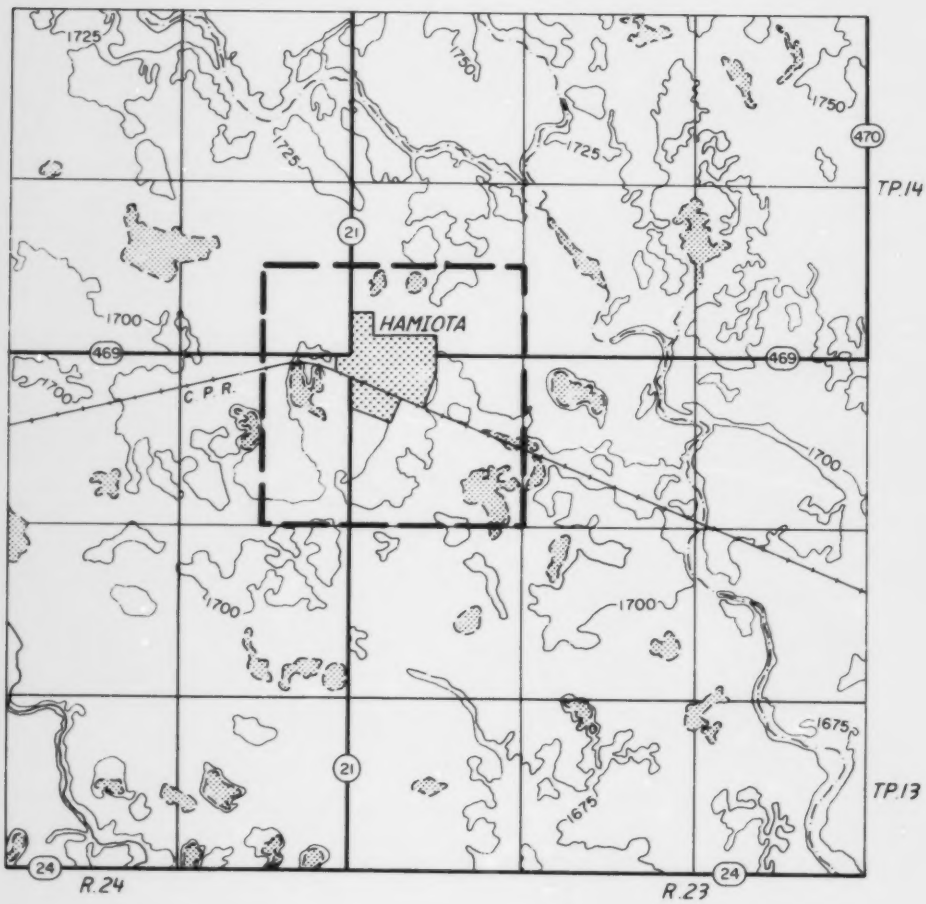


Figure 3d: Relief and Drainage Map of the Hamiota Townsite.

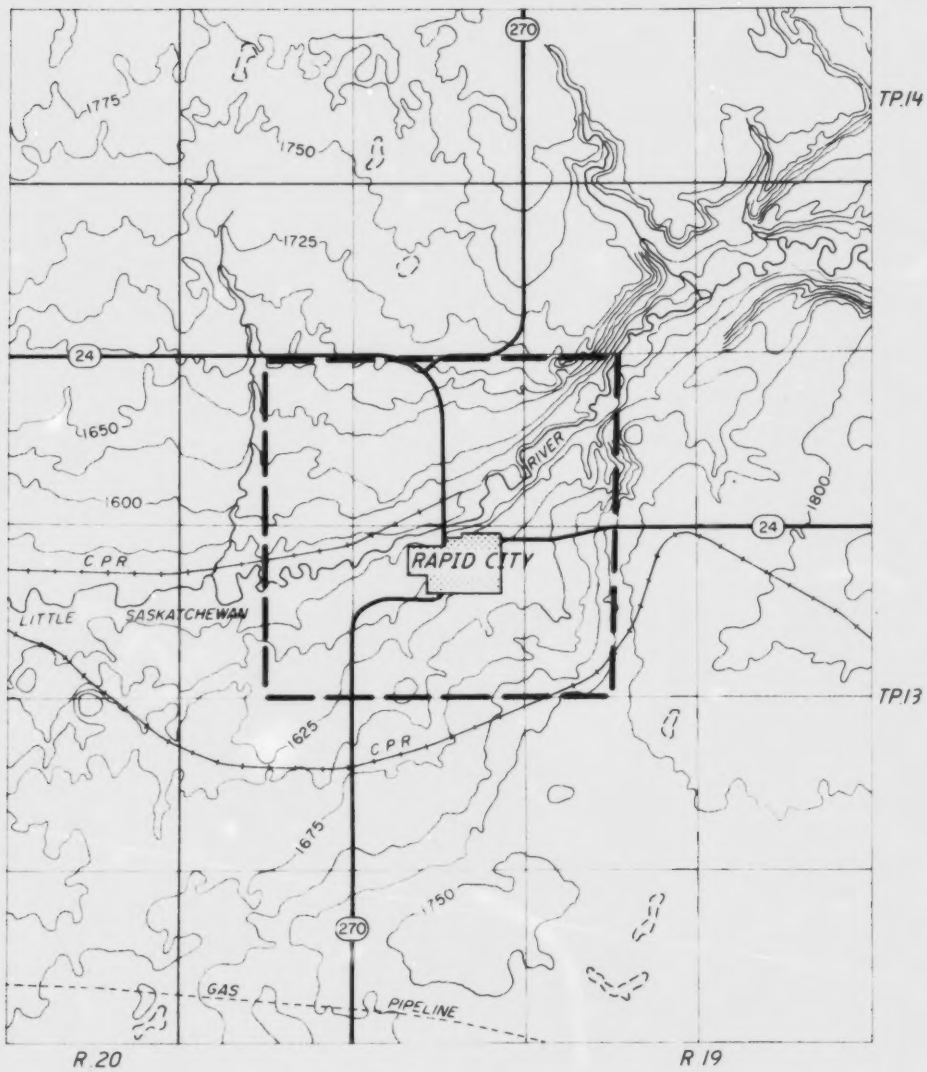


Figure 3e: Relief and Drainage Map of the Rapid City Townsite.

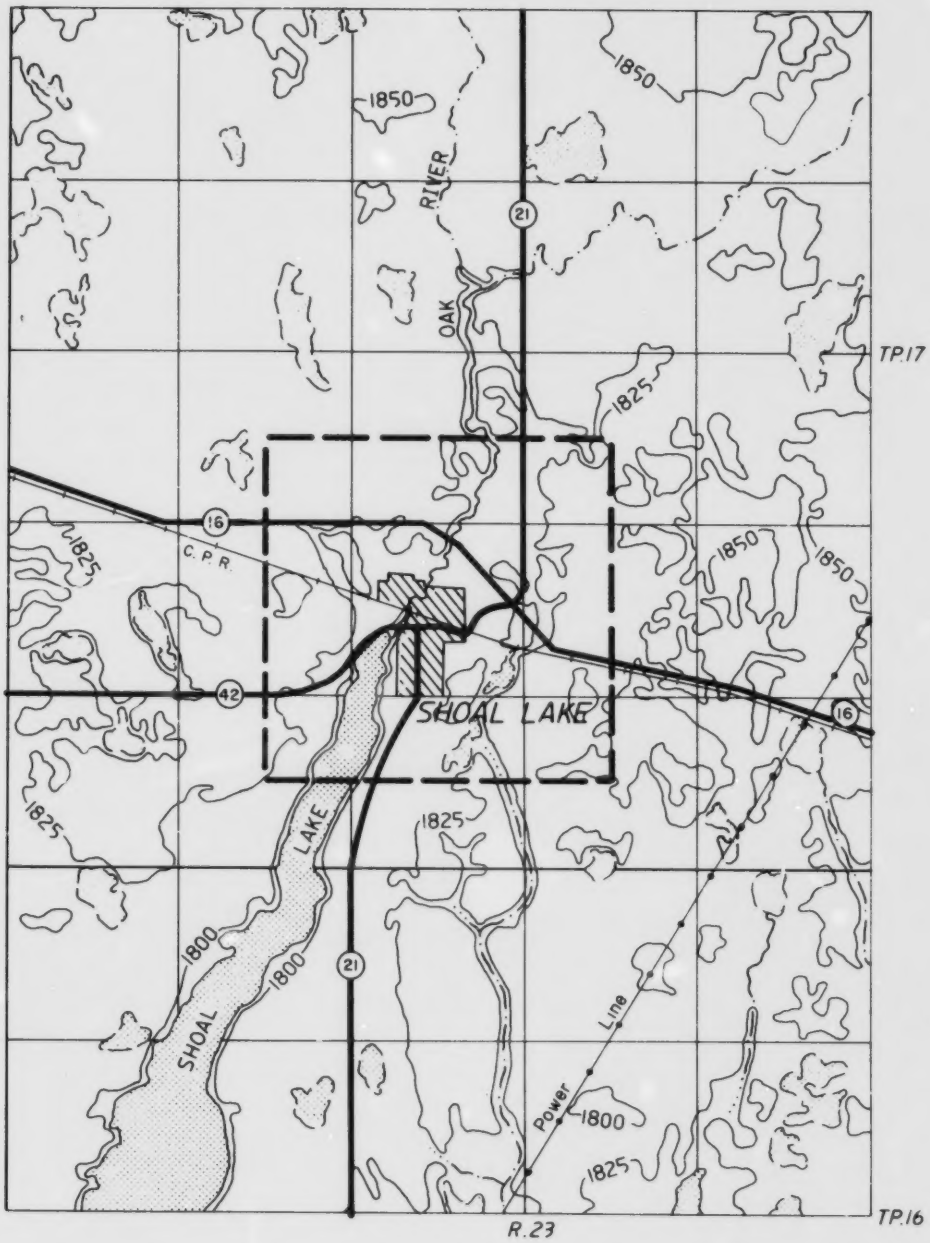


Figure 3f: Relief and Drainage Map of the Shoal Lake Townsite.

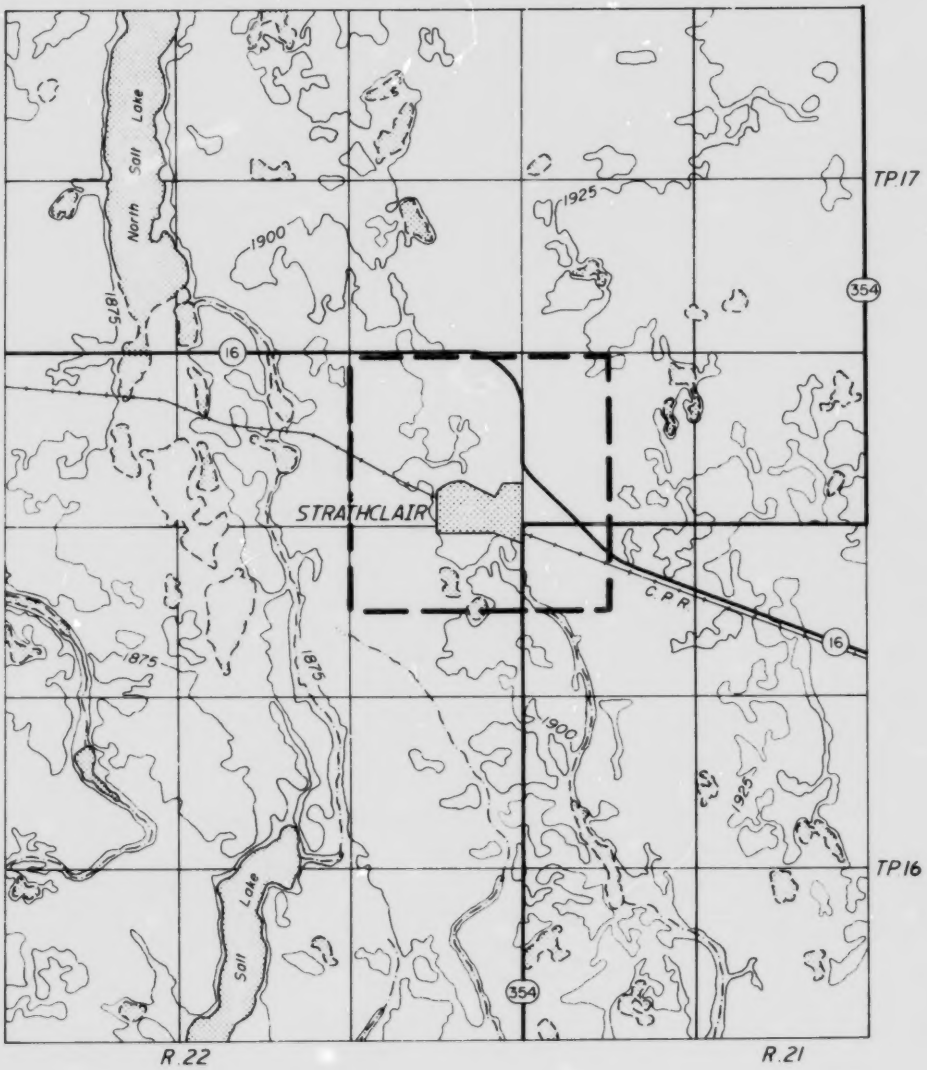


Figure 3g: Relief and Drainage Map of the Strathclair Townsite.

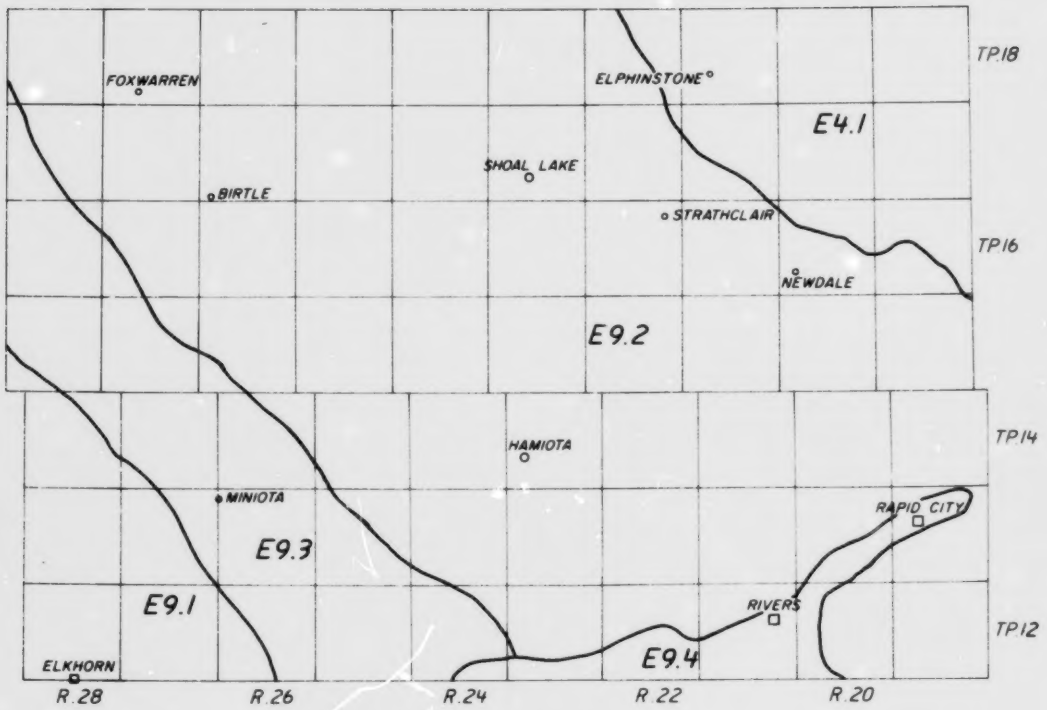
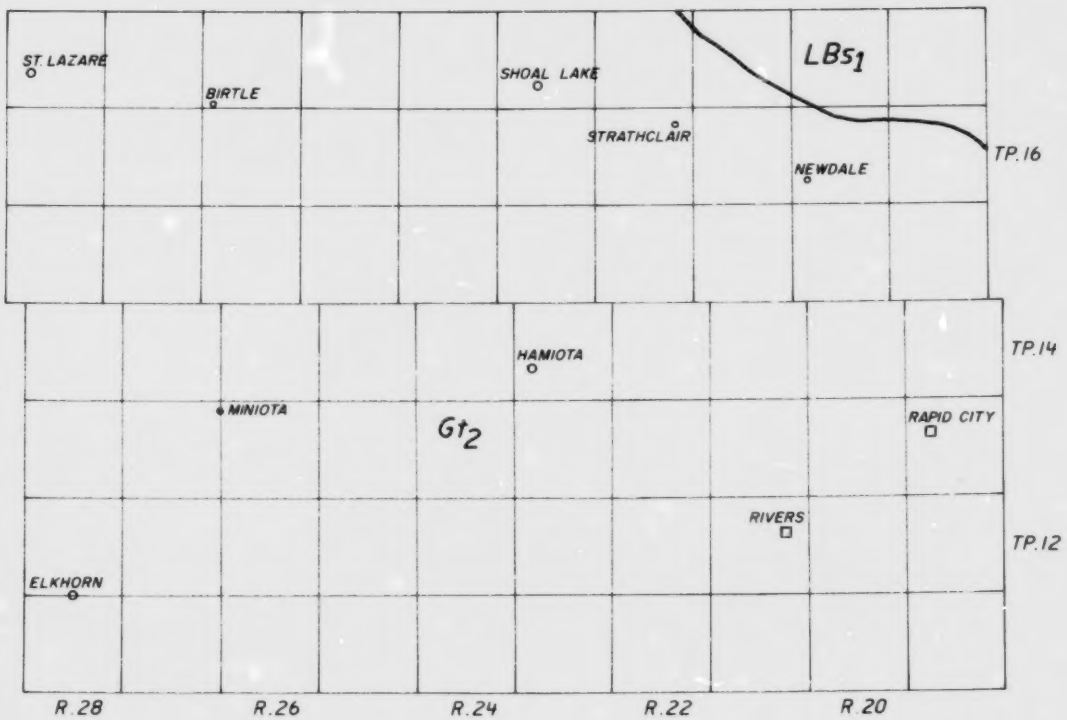


Figure 4: Physiographic Regions of the Study Area.



Ecoclimatic Region	Sub-region	Dominant Soils	Soil Climate		Vegetation Zone
			Temperature Class	Moisture Subclass	
Grassland Transition	Gt_2	Chernozemic Black, Gleysols	Boreal, cool to moderately cool	Subhumid	Grassland and Aspen Parkland
Low Boreal subhumid	LBs_1	Chernozemic Dark Gray, Brunisolic, Organic	Cryoboreal, moderately cold	Subhumid	Grassland-forest transition

Figure 5: Ecoclimatic Regions of the Study Area.

PART 2

METHODOLOGY

2.1 MAPPING

Soil mapping in this project was conducted by soil surveyors employing an intensive grid or systematic sampling method. Soil profiles were examined to a depth of one meter at sites approximately 150 meters apart along foot traverses that, in turn, were spaced approximately 0.8 km apart. In this project, the initial inspection point in each section was located 50 to 100 meters from a road allowance fence approximately .4 km from a selected corner of the section to be surveyed. The direction each traverse took was determined on the basis of maximizing the information that could be derived from the range of known soil-landscape variation in each section. Additional sites along road allowances were also examined to help locate soil boundaries between sections. This method of sampling provided approximately 25 to 30 inspection sites per section, or put another way, each site represented approximately 8 to 10 ha. This intensity of sampling permitted the confident delineation of soil mapping units comprised of narrowly defined soil types and other landscape features such as slope, stoniness and erosion on maps at a scale of 1:20,000 (3 inches equal one mile).

2.2 MAP UNITS

A map unit[5] represents mappable portions of the soil landscape that together have characteristics and properties varying within more or less narrow limits that are determined by the intensity of the survey. A map unit contains predominantly one or more than one soil or nonsoil individual plus a certain proportion (varying within prescribed limits) of unnamed and undescribed inclusions. They are delineated on the basis of the types and relative proportions of their soils or nonsoils, as well as on the basis of external criteria such as slope, stoniness or erosion.

Soil maps show the distribution of kinds of soils and, as such, serve as a link so that the knowledge gained in one locality about the usefulness or behavior of a kind of soil can be extended to other bodies of the same soil.

A map unit comprises all delineations that contain exactly the same symbol. This includes all the characters denoting soils, nonsoils, phases and deciles. While they represent real portions of the landscapes, most map units are concepts

[5] A more complete description or definition is contained in the report: Mapping Systems Working Group. 1981. A Soil Mapping System for Canada: Revised. Land Resource Research Institute, Contribution No. 142, Agriculture Canada, Ottawa.

because their total range of properties is made up of the aggregate of all their delineations and no one delineation will contain the full range of properties. The proportions of each of the component soils and nonsoils and undescribed inclusions may vary within reasonable limits from one delineation to another.

A map unit is named from its principal component soils or nonsoils. It is described in terms of the properties of these components, their relative proportions and other external land attributes. In this project, units are described in terms of named soil series and phases of soil series. The soil series is defined as a naturally occurring soil body such that any profile within that body has a similar number and arrangement of horizons whose colour, texture, structure, consistence, reaction and composition are within a narrowly defined range.

Map units will always contain small proportions of inclusions. These inclusions may be soil or nonsoil mapping individuals that are named and have their own map units elsewhere in the survey, or they may be rare or insignificant soils or nonsoils that are not recognized or named at all in the survey. They may, however, be mentioned in the description of soil types in the report.

2.3 SIMPLE AND COMPOUND MAP UNITS

There are two major types of map units[6]: simple and compound. The difference between them is defined in terms of the proportion and contrast of their components.

A Simple Map Unit contains predominantly one soil or nonsoil. The proportion of its components vary according to their areal extent and contrasting characteristics as they may affect soil management or use. Its components vary as follows: the predominant component comprises at least 65 percent with up to 35 percent of nonlimiting, similar components (components are alike in most properties and behaviour), or up to 25 percent of nonlimiting dissimilar components (components do not affect management of the map unit but does have a significant number of properties that vary from the predominant to component), or up to 15 percent of limiting, dissimilar components (components have many constrasting properties and usually affect management differently).

A Compound Map Unit contains predominantly two soils or nonsoils (or a combination of both). The proportions of the two major components may vary from one considerably exceeding the other to both being approximately equal. Complementary to the definition of a single map unit, the proportions of its components vary according to their areal extent and contrasting characteristics as they may affect soil management or use. Its major components vary as follows: if other components are similar and nonlimiting no single component represents more than 65 percent; or if other components are dissimilar and nonlimiting no single component represents 75 percent or more; or if other components are dissimilar and limiting no single component represents 85 percent or more.

A soil or nonsoil may occur in more than one compound unit. The complex nature of soil landscapes requires that the surveyor be allowed

[6] See reference to the Soil Mapping System for Canada: Revised for a more complete description of mapping units.

the freedom to describe their combinations as they occur. For the purpose of describing compound map units, components are considered dominant if they occupy over 40 percent of the unit, significant from 15-40 percent and minor if they occupy less than 15 percent. Minor components are described only if they are highly contrasting.

2.4 PHASES

It is frequently desireable to indicate by map unit symbol, a condition or quality of soil property or landscape feature that deviates significantly from the normal definition of map units. These indicated variations or phases of soil properties and landscape features, varying from delineation to delineation, significantly affect soil behavior and land management or use.

It is not always easy to maintain a clear distinction between a soil phase and a land phase. Soil properties that are frequently used as phase criteria include texture depth, surface peat, salinity and physical disruption. Properties of land that are used include slope, wind and water erosion, stoniness, rockiness and altered drainage.

In this study the effect of four properties and land features are shown as a character in the denominator of the map unit symbol and described outside the main soil map legend. The four properties and features are erosion, slope class, degree of stoniness and salinity. The degree or magnitude of each is designated in the following manner;

Erosion

x - none-eroded or minimal
1 - weakly eroded
2 - moderately eroded
3 - severely eroded
O - overblown

Slope Class

x - 0 to 2% level to nearly level
c - 2 to 5% very gently sloping
d - 5 to 9% gently sloping
e - 9 to 15% moderately sloping
f - 15 to 30% strongly sloping
g - 30 to 45% very strongly sloping
h - 45 to 70% extremely sloping

Stoniness

x - non stony
1 - slightly stony
2 - moderately stony
3 - very stony
4 - exceedingly stony
5 - excessively stony

Salinity

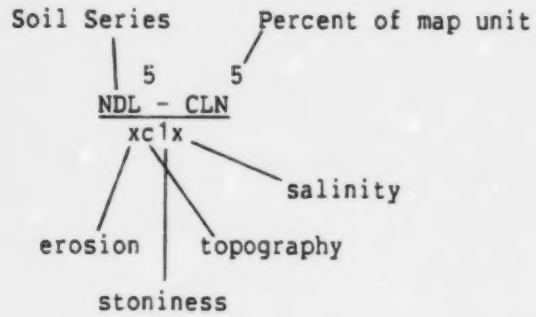
x - non saline (0-4 mS/cm)
s - slightly saline (4-8 mS/cm)
t - moderately saline (8-15 mS/cm)
u - strongly saline (>15 mS/cm)

The convention employed to indicate these features in the map symbol is as follows:

If none of the above properties are observed to be significant, the map symbol representing the normal or unaffected soil series is used alone without modifiers.

If one or more phase features are recognized, the appropriate letter or number is placed below the soil series symbol in one of four designated locations in the map unit symbol. The designated order is erosion, slope class, stoniness and salinity. If a particular feature is not observed to be significant, an x is used in its appropriate designated location in the map symbol.

For example, the compound map unit coded:



Is interpreted to mean that 50 percent of the mapping unit consists of Newdale (NDL^5) series having no erosion (x), very gently sloping (c) topography, slight (1) stoniness, no salinity (x): and 50 percent Clementi (CLN^5) series having no erosion (x), very gently sloping (c) topography, slightly stony (1) surface conditions and no (x) salinity.

Definitions of the erosion, topography, stoniness and salinity classes are given in the Glossary.

2.5 SAMPLING

During the course of field investigations and mapping, soil samples were taken at selected locations for soil characterization, salinity and irrigation suitability studies. One profile was described in detail and sampled for soil characterization analysis (Appendix F). In areas where salinity was suspected to be a problem particularly at Shoal Lake, Elkhorn and Newdale, soils were sampled at 10 to 25 cm and at 50 to 60 cm for electrical conductance measurements and soluble salt analysis. Relatively high levels of sodium sulphate have been analyzed in many of the samples.

PART 3

FORMATION, CLASSIFICATION AND MORPHOLOGY OF SOILS

3.1 SOIL DEVELOPMENT

Soil genesis is the process or processes responsible for the development of soil. The principal factors of climate, vegetation, relief and drainage act upon the unconsolidated parent material to produce the soil profile. The type of soil formed in any one place is dependent upon the interaction of these factors and upon the length of time they have been active.

In the study area, the degree of soil development is related to the regional climate and the degree of leaching, translocation and accumulation of the soluble and colloidal fractions of the soil. In grassland areas, the amount of water available for leaching is relatively low, but sufficient to support grassland vegetation; this results in accumulation of organic matter in the mineral surface horizons and gives the soils the "black color". The translocation of soluble and colloidal fractions is relatively shallow. A majority of the study area is mapped as Chernozemic Black soils developed under cool to mod. cool, subhumid Boreal climatic conditions. In parkland areas (transition from grassland to forest), the soil climate is favorable for tree growth as well as grassland species. There is a greater degree of leaching and translocation than in the grassland area proper, and less organic matter accumulation. The result is the formation of soils with a "dark gray" surface and identifiable accumulation of translocated products such as clay and organic matter lower in the soil profile.

Under more favorable moisture conditions of the forested areas, there is a greater degree of leaching and translocation of soluble and colloidal soil material resulting in soils with a characteristic leaf mat, a bleached light coloured zone and an accumulation zone dominantly of the translocated clay and organic matter. These soils are classified as Luvisols.

The project area is largely in a transition from grassland to forested soils occuring over a broad expanse of gently sloping ground moraine between the Lake Souris Basin and the Riding Mountains. Here the change in climatic conditions and native vegetation is very gradual and a large portion of the transitional area is occupied by soils which show the effect of increasing moisture efficiency but do not exhibit the degree of leaching commonly associated with Dark Gray Chernozemic or the "Gray-Black sub-zone." These soils have been classified as slightly degrading Blackearth soils or the "Northern Blackearths" in the 1956 Rossburn-Virden soil survey report. They differ from the normal Black Chernozems mainly in the development of a brown coarse granular to blocky "B" horizon of about equal thickness as the overlying black to very dark gray "A" horizon.

In a similar climatic region, soils may differ due to the texture

and mineralogical composition of the parent material. Soils developed on sandy to loamy materials are more permeable to water and allow for a greater leaching of the soluble and colloidal fraction as compared to finer textured soils. Soils developed on moderately calcareous sediments are noticeably deeper than soils developed on strongly calcareous sediments; soils developed on extremely calcareous material are very shallow because of the difficulty of leaching the large quantity of lime carbonate present; the maximum depth of soil development on these extremely calcareous materials is 20 to 30 cm.

Restrictions on normal soil development are not only imparted by high levels of lime carbonate, but also by the length of the saturation period in an area affected by surface ponding, lateral inflow, seepage or near surface groundwater. Under these conditions, the leaching of soluble and colloidal material is minimal, and in some cases the translocation of soluble soil material is toward the surface; the soil environment is altered from an oxidative state to a depleted oxygen or reductive state. The characteristics associated with various restricted drainage and hydrological conditions are dull soil colors, the development of mottles of iron and manganese, the presence of lime carbonate near the surface of the soils (not applicable to better drained shallow soils developed on extremely calcareous materials), the presence of, and the accumulation of soluble salts within the rooting zone, and the accumulation of peat at the surface.

The soils in the study area characterized by poor drainage are classified as Gleysols. The youthful soils of the study area occuring along the Minnedosa River and Birdtail Creek, lack genetic horizons and are classified as Regosols.

3.2 DESCRIPTION OF SOIL SERIES

The soil series of the study area are described in alphabetical order and include a general description of the genetic profile type, texture, parent material, topography and drainage. General statements on the distribution, surface runoff, stoniness, erosion and vegetation characteristics are also given. A convenient, abbreviated key form of table reference on the relationship of soil series in the study to soil drainage, subgroup and parent material is provided in Table 2. A more comprehensive grouping of soils and parent materials is presented in Table 3.

Table 2. Soil Series of the Study Area Arranged in Relation to Soil Moisture Class, Subgroup and Parent Material.

Soil Moisture Class	Subgroup	PARENT MATERIALS								
		Outwash	Outwash over Till	Glacial Till	Lacustrine over Outwash		Lacustrine over Till	Lacustrine over Outwash over Till	Alluvium	Undifferentiated
		Sandy Skeletal (Gr,Gr.S,S)	Sandy Skeletal/ Loamy (L,CL,SiCL) Till	Fine Loamy (L,CL,SiCL)	Loamy (L,CL, SiCL)/Sandy Skeletal	Coarse Loamy (VFS,LVFS,SL, FSL)/Sandy Skeletal	Loamy (L, SiL,SiCL,CL)/ Loamy (L,CL SiCL) Till	Loamy (L,CL,SiCL)/ Sandy Skeletal/ Loamy (L,CL,SiCL) Till	Loamy (FSL,L,SiL SiCL,CL) Stratified	
Well	Orthic Black Calcareous Black Rego Black	Dorset(DOT) Marringhurst(MRH)	Chater(CXW)	Newdale(NDL) Cordova(CVA) Rufford(RUF)	Croyon(CYN)	Miniota(MXI)	Clementi(CLN)	Jaymar(JAY)		Eroded
Imperfect	Gleyed Cumulic Regosol Gleyed Black Gleyed Rego Black Gleyed Eluviated Black			Varcoe(VRC) Angusville (ANL)	Druxman(DXM) Capell(CXT)		Cobfield(CBF) Beresford(BSF)	Melland(MXT)	Levine(LEI)	Slopes Complex (ERX)
Poor	Rego Humic Gleysol Humic Luvic Gleysol			Drokan(DRO) Penrith(PEN)	Carvey(CAV)		Vodroff(VFF)	Marsden(MDN)	Basker(BKR)	Marsh Complex (MHC)

TABLE 3

Key to the Soils in the Study Area

A. Soils developed on fluvial outwash.

1. Deep (>1 m) moderately to strongly calcareous, stratified (medium sand to gravelly) sandy skeletal, fluvial outwash or beach deposits consisting of dominantly limestone and granitic fragments.

a) Well drained

- Dorset series (Orthic Black) DOT
- Marringhurst series (Calcareous Black) MRH

B. Soils developed on fluvial outwash overlying glacial till.

1. A thin mantle (<1 m) of moderately to strongly calcareous, sandy skeletal (Gr, GrS, S), outwash deposits overlying moderately to strongly calcareous, fine loamy (L, CL, SiCL) glacial till derived from shale, limestone and granitic origin.

a) Well drained

- Chater series (Calcareous Black) CXW

C. Soils developed on glacial till.

1. Deep (>1 m) moderately to strongly calcareous, fine loamy (L, CL, SiCL) glacial till derived from shale, limestone and granitic materials.

a) Well drained

- Newdale series (Orthic Black) NDL
- Cordova series (Calcareous Black) CVA
- Rufford series (Rego Black) RUF

b) Imperfectly drained

- Varcoe series (Gleyed Rego Black) VRC
- Angusville series (Gleyed Eluviated Black) ANL

c) Poorly drained

- Drokan series (Rego Humic Gleysol) DRO

- Penrith series (Humic Luvic Gleysol) PEN

D. Soils developed on shallow lacustrine deposits overlying sand and gravel outwash.

1. A thin mantle (<1 m) of moderately to strongly calcareous, loamy (L, CL, SiCL) lacustrine sediments overlying moderately to strongly calcareous, sandy skeletal (S, GrS) outwash deposits.

a) Well drained

- Croyon series (Orthic Black) CYN

b) Imperfectly drained

- Druxman series (Gleyed Black) DXM
- Capell series (Gleyed Rego Black) CXT

c) Poorly drained

- Carvey series (Rego Humic Gleysol) CAV

2. A thin mantle (<1 m) of weakly to strongly calcareous, coarse loamy (VFS, LVFS, FSL, SL) lacustrine sediments overlying moderately to strongly calcareous, sandy skeletal (S, GrS) fluvial outwash.

a) Well drained

- Miniota series (Orthic Black) MXI

E. Soils developed on lacustrine deposits overlying glacial till.

1. A thin mantle (<1 m) of moderately to strongly calcareous, loamy (L, CL, SiCL) lacustrine sediments over moderately to strongly calcareous, loamy (L-CL) glacial till of shale, limestone and granitic origin.

a) Well drained

- Clementi series (Orthic Black) CLN

b) Imperfectly drained

- Cobfield series (Gleyed Black) CBF
- Beresford series (Gleyed Rego Black) BSF

c) Poorly drained

- Vodroff series (Rego Humic Gleysol) VFF

F. Soils developed on lacustrine or fluviolacustrine deposits over a zone of fluvial outwash underlain by glacial till.

1. A thin mantle (40-70 cm) of moderately to strongly calcareous, loamy (L-CL) lacustrine sediments over a thin (30-60 cm) contact layer or wash zone of sandy skeletal (S, GrS) materials overlying moderately to strongly calcareous, loamy (L, CL, SiCL) glacial till of shale, limestone and granitic origin.

a) Well drained

- Jaymar series (Orthic Black) JAY

b) Imperfectly drained

- Melland series (Gleyed Rego Black) MXT

c) Poorly drained

- Marsden series (Rego Humic Gleysol) MDN

G. Soils developed on alluvium.

1. Deep (>1 m), moderately to strongly calcareous, stratified, loamy (FSL, VFSL, L, SiL, CL) alluvial (recent fluvial) sediments.

a) Imperfectly drained

- Levine series (Gleyed Cumulic Regosol) LEI

b) Poorly drained

- Basker series (Rego Humic Gleysol) BKR

H. Undifferentiated

1. Soils developed on undifferentiated materials with a range in properties and generally lacking genetic profile development.

a) Eroded Slopes complex ERX

b) Marsh complex MHC

Angusville Series (ANL)

Angusville series is characterized by a Gleyed Eluviated Black soil profile developed on moderately to strongly calcareous, slightly stony, fine loamy (L-CL) morainal till of limestone, granitic and shale bedrock origin. These soils are imperfectly drained and occur in lower to mid slope positions of undulating to hummocky landscapes, in close association with the well drained Newdale, Rufford and Cordova soils, the imperfectly drained Varcoe series, the poorly drained Drokan and Penrith series. Surface runoff is slow to moderately slow; permeability is moderately slow to slow within the solum and moderately slow in the subsoil. Vegetation on non-cultivated lands consists of trembling aspen.

The average thickness of the soil profile is 83 cm and varies from 45 to 100 cm. The A horizon has a mean thickness of 32 cm and ranges from 20 to 50 cm. The very dark gray to gray Ap horizon is 15 to 20 cm thick, and the dark gray to gray Ahe horizon, 5 to 30 cm thick. The dark brown to dark yellowish brown Btj or Bt horizon is 25 to 35 cm thick. A lime enriched layer of 10 to 20 cm is usually present. The C horizon is light olive brown with yellowish brown mottles. The Angusville soil profile is more strongly developed, deeper and free of lime carbonate as compared to the closely associated, shallower, carbonated Gleyed Rego Black Varcoe series.

Basker Series (BKR)

The Basker series consists of poorly to very poorly drained Rego Humic Gleysol soil developed on moderately to strongly calcareous, stratified, loamy (FSL,VFSL,L,SiL,SiCL), recent alluvial deposits. These soils occur in depression positions of nearly level slopes on flood plain landscapes and have slow permeability, very slow surface runoff, and a high water table during the growing season. Basker soils are slightly water eroded, non-stony, and occasionally slightly saline. They have a high available water holding capacity, medium organic matter content, and low natural fertility. Native vegetation includes sedges, rushes and willows. The majority of these soils are currently in native vegetation because they are subject to flooding and saturated conditions in the spring.

In a representative profile of Basker soil there is no soil solum. The profile is characterized by light grayish brown Ahk horizon, 5 to 20 cm thick, with iron stains, and a stratified, olive brown Ckg horizon, with prominent iron mottles in the sandy strata. A typical profile also contains thin organic layers indicating former surfaces.

Basker soils occur in close association with Levine soils. They are similar to Kerran soils by having a poorly drained profile developed in recent alluvium but differ from them in having mostly loam rather than clay textures. Basker soils were previously mapped as Meadow associates of the Assiniboine Complex in the Rossburn-Virden Sheet.

Beresford Series (BSF)

The Beresford series consists of imperfectly drained Gleyed Rego Black, carbonated soils developed on a thin mantle (<1 m) of loamy (L, Sil, CL, SiCL) lacustrine sediments over strongly to very strongly calcareous, loam to clay loam glacial till of shale, limestone and granitic origin. These soils occur on nearly level to undulating topographic land-

scapes in association with the Clementi (Orthic Black) soils. They occur in landscapes which are considered to be in a discharge to weak recharge (groundwater) area and may have soluble salts within the rooting zone or subsoil. The runoff is slow, and permeability is moderately slow to slow.

The Beresford soils are characterized by a very dark gray to black Ah horizon 20 to 30 cm, a dark gray ACk horizon of 6 to 12 cm thick. A lime accumulation zone may occur in the loamy lacustrine sediments if the overlay is thick; the underlying strongly calcareous till of shale limestone and granitic origin is generally more compact.

Capell Series (CXT)

The Capell series consists of imperfectly drained Gleyed Rego Black soil developed on a mantle (25 to 100 cm) of moderately to strongly calcareous, stratified, loamy (SiCL, L, CL), lacustrine sediments over moderately to strongly calcareous, deep stratified, sandy to sandy-skeletal (GrS, GrLS), glaciofluvial deposits. These soils occur in lower slope positions of gentle to moderate slopes on hummocky landscapes and have moderate to rapid permeability, moderate surface runoff and a medium water table during the growing season. Capell soils are occasionally slightly saline. They have medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes tall prairie and meadow grasses. The majority of these soils are currently used for grain crop production.

In a representative profile of Capell soil the solum is approximately 25 cm thick. The profile is characterized by a very dark gray to black Apk or Ahk horizon, 15 to 25 cm thick, a dark gray to gray, calcareous AC horizon, 5 to 15 cm thick, a light gray IICca horizon, 5 to 10 cm thick with secondary carbonate accumulation and a light yellowish brown IICk horizon with common, distinct iron mottles.

Capell soils occur in close association with Croyon and Carvey soils. They are similar to Druxman soils by having the same sequence of parent materials and the same natural drainage but differ from Druxman soils because of a more weakly developed profile than that typical of Druxman soils. Capell soils were previously mapped as an imperfectly drained associate of the Marringhurst Association in the reconnaissance soil survey of the Rossburn-Virden Area (1956).

Carvey Series (CAV)

The Carvey series consists of poorly drained Rego Humic Gleysol soil developed on a mantle (25 to 100 cm) of moderately to strongly calcareous, uniform, loamy (SiCL, L, CL) lacustrine sediments over moderately to strongly calcareous, sandy to sandy skeletal glaciofluvial deposits. These soils occur in depressional positions of nearly level slopes on level landscapes and have moderate permeability slow surface runoff and a high water table during the growing season. Carvey soils are occasionally slightly saline. They have medium over low available water holding capacity, high organic matter content, and medium natural fertility. Native vegetation often includes sedges and meadow grasses. The majority of these soils are currently used for natural grazing.

In a representative profile of Carvey soil the solum is approximately 20 cm thick. The profile is char-

acterized by a thin (2 to 5 cm) moderately decomposed LFH horizon a very dark gray, calcareous Ah horizon, 7 to 15 cm thick and a dark gray, calcareous, transition AC horizon, 10 to 20 cm thick, and a pale brown, calcareous IICk horizon with yellowish brown mottles. A typical profile also contains manganese concretions in the subsoil and shells at the surface.

Carvey soils occur in close association with Capell, Druxman and Croyon soils. They are similar to Tadpole soils by having a Rego Humic Gleysol profile developed in loamy lacustrine deposits, but differ from Tadpole soils by having a sandy to sandy-skeletal substrate within a meter of the mineral surface. Carvey soils were previously mapped as a Meadow associate with loamy veneer of the Marringhurst Association in the Rossburn-Virden (1956) soil report.

Chater Series (CXW)

The Chater series is a Calcareous Black soil developed on moderately well to well drained, moderately to strongly calcareous, sandy (S,CS) to sandy-skeletal (GrS< GrCS) outwash and glaciofluvial deposits, less than one meter in depth, overlying moderately to strongly calcareous loamy (L, CL) glacial till deposits. These soils occur in gently undulating to moderately rolling topography. Surface runoff is moderately rapid while permeability is rapid in the coarser deposits and moderate to moderately slow in the underlying till material. These soils are in favorable topographic positions to allow excess water above the till to flow laterally to downslope positions.

The Chater soil profile is characterized by a 12 to 18 cm thick, very dark gray Ah horizon and a grayish brown to brown Bmk horizon of 8 to 15 cm thickness, with a lime accumulation horizon in the coarser stratum.

Chater soils are coarser textured and tend to be droughtier than the similar Clementi soils.

Clementi Series (CLN)

The Clementi series is characterized by an Orthic Black profile developed on a thin overlay (25 to 90 cm) of loamy fluvial or lacustrine sediments over moderately to very strongly calcareous morainal till of limestone, granitic, and shale origin. These soils are moderately well drained and occur in mid to upper slope positions of very gently undulating or rolling topography. Runoff is moderate; permeability is moderate in the loamy overlay, and moderately slow to slow in the underlying till.

The solum has a very dark gray to black Ah horizon, 10 to 20 cm thick and a dark brown to brown Bm horizon, 8 to 12 cm thick. The solum is developed dominantly within the overlay, and may extend into the till material.

Cobfield Series (CBF)

The Cobfield series is a Gleyed Black soil developed on imperfectly drained loamy (L, CL, SiCL) lacustrine sediments, less than one meter in depth, overlying moderately to strongly calcareous loamy (L, CL) glacial till deposits. These soils occur in the mid to lower slope position of gently sloping to undulating topography of dominantly weak recharge areas. The runoff is moderately slow with permeability being moderate in the upper lacustrine sediments and moderately slow to slow in the underlying glacial till.

The Cobfield soil profile is characterized by a very dark gray to black Ah horizon 10 to 18 cm thick, a brown to dark yellowish Bm horizon of 8 to 12 cm thick, with few, yellowish brown to strong brown mottles, and a lime accumulation horizon. The underlying till is olive brown to light olive brown, which is indicative of periodic saturation and reducing conditions.

In this project area, the A horizon is 22 cm thick and varies from 15 to 35 cm; the depth of solum is 41 cm and varies from 25 to 75 cm. The Cordova series differs from the Rufford series, a carbonated Rego Black in having a Bmk horizon. Both Cordova and Rufford series differ from the Newdale series, the former having free lime carbonate present in the solum, while the latter has an A and B horizon free of carbonates.

Cordova Series (CVA)

The Cordova series is characterized by a Calcareous Black solum on moderately to strongly calcareous, slightly to moderately stony, loamy (L-CL) morainal till of mixed limestone, granitic and shale rock origin. These soils are well to rapidly drained and occur in the upper slope and crest positions of undulating to hummocky landscapes, in close association with the well drained Rufford and Newdale series. Surface runoff is moderately rapid to rapid, depending upon slope. Permeability is moderately slow. Native vegtation consists of mixed tall prairie grasses and herbs.

The Cordova soil profile has a thin, very dark gray Ap(k) horizon, 12 to 18 cm thick, a calcareous, yellowish brown to dark yellowish brown Bm horizon, 5 to 15 cm thick, a thin transitional BC horizon and a light gray lime carbonate accumulation layer, 25 to 35 cm thick. Secondary carbonates may be found along vertical cracks within the underlying grayish brown (dry) or dark grayish brown (moist) Ck horizon. In many areas, these soils have been altered by wind and water erosion; the crest positions have lost most of the A horizon and part of the B horizon has been cultivated. In a few areas, the Cca horizon has been incorporated into the plow layer, imparting a light gray surface color.

Croyon Series (CYN)

The Croyon series consists of moderately well to well drained Orthic Black soil developed on a mantle (25 to 100 cm) of moderately to strongly calcareous, uniform, loamy (L, SiL, CL) lacustrine sediments over moderately to strongly calcareous, stratified, deep sandy-skeletal (GrS, GrLS), glacio-fluvial deposits. These soils occur in middle and upper slope positions of very gentle slopes on undulating landscapes and have medium over rapid permeability moderately rapid surface runoff and a low water table during the growing season. Croyon soils have medium available water holding capacity, medium organic matter content, and high natural fertility. Native vegetation often includes tall prairie grasses interspersed with aspen-oak groves. The majority of these soils are currently used for grain crop production.

In a representative profile of Croyon soil the solum is approximately 35 cm thick. The profile is characterized by a very dark gray Ah or Ap horizon, 10 to 15 cm thick, a dark brown Bm horizon, 10 to 25 cm thick, a yellowish brown IICca horizon, 10 to 20 cm thick with secondary carbonate accumulation and a light yellowish brown IICk horizon. The parent material is typically stratified with

thin (<5 cm) layers of SiL, CS, GrS and SL textures.

Croyon soils occur in close association with Zarnet, Capell and Druxman soils. They are similar to Vandal soils by having a coarse-loamy mantle over sandy-skeletal deposits at depth but differ from the Orthic Dark Gray Vandal soils in having a less strongly developed Orthic Black soil profile. Croyon soils were previously mapped as loamy surface associates of the Marringhurst association in the reconnaissance soil survey of the Rossburn-Virden Area (1956).

Croyon Series, shaly gravel substrate variant (CYN1)

The Croyon series shaly gravel variant, occurs in close association with typical Croyon soils and differs in having dominantly shale derived coarse fragments in the sandy-skeletal substrate.

Dorset Series (DOT)

The Dorset series consists of moderately well to well drained Orthic Black soil developed on moderately to strongly calcareous, deep, stratified, sandy to sandy skeletal (S,GrS,GrCS), outwash and glaciofluvial deposits. These soils occur in upper positions of gentle slopes on hummocky landscapes and have very rapid permeability, moderate to moderately rapid surface runoff, and a low water table during the growing season. Dorset soils are non-eroded, non-stony, and non-saline. They have a low available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes aspen-oak stands and tall prairie grasses. The majority of these soils are currently used for grazing or excavated for gravel deposits.

In a representative profile of Dorset soil the solum is approximately 30 cm thick. The profile is characterized by a very dark gray Ah horizon, 12 to 18 cm thick, a dark brown Bm horizon, 15 to 22 cm thick, a Cca horizon, 6 to 12 cm thick with lime accumulation and a light brown Ck horizon, with stratified sands and gravels.

Dorset soils occur in close association with Mansfield, Dexter and Fortina soils. They are similar to Marringhurst soils by having well drained profile in glaciofluvial deposits but differ from them in having a Bm horizon. Dorset soils were previously mapped as Blackearth associates of the Marringhurst Association in the Rossburn-Virden (1956) soil report.

Drokan Series (DRO)

The Drokan series is characterized by a Rego Humic Gleysol (carbonated) solum, developed on moderately to strongly calcareous, loamy (L-CL) morainal till of limestone, granitic and shale rock origin. They are poorly to very poorly drained and occur in depressional positions of the undulating to hummocky morainal landscape. Surface runoff is negligible and the soils may remain in a ponded condition unless the surface drainage had been improved. Permeability is moderately slow to slow. In some landscapes, these areas are influenced by seepage from adjacent higher lands, and may have a considerable content of soluble salts. Native vegetation consists of sedges, cattails, rushes and willows. Saline areas have baltic rush, wild barley and saline goosefoot.

The Drokan soil profile has a moderately decomposed organic layer, 2 to 5 cm thick, a very dark gray Ah horizon, 10 to 18 cm thick, a mottled transitional AC horizon, 4 to 8 cm thick and a lime accumulation layer, 8 to 12 cm thick. The C horizon is olive gray to olive with yellowish brown mottles. Gypsum crystals are common in the lime accumulation layer and C horizon. In saline areas, white flecks of salt and gypsum are present above the lime accumulation layer in the Ah and AC horizons; soils with appreciable soluble salts are delineated as Drokan saline phase.

In this study area, the average A horizon is 22 cm thick and varies from 15 to 35 cm; the average depth of its solum is 35 cm and varies from 15 to 70 cm. It differs from the closely related Penrith soil series in being less well developed and having shallower, less distinct horizons.

Druxman Series (DXM)

The Druxman series consists of imperfectly drained Gleyed Black soil developed on a mantle (25 to 100 cm) of moderately to strongly calcareous, loamy (L, CL) lacustrine sediments over stratified, deep, sandy-skeletal (GrS, GrLS), glacio-fluvial deposits. These soils occur in lower slope positions of very gentle slopes on undulating landscapes and have medium over rapid permeability, moderately slow surface runoff and a medium water table during the growing season. Druxman soils have medium available water holding capacity, medium organic matter content and medium natural fertility. Native vegetation often includes meadow and tall prairie grasses interspersed with willow clumps. The majority of these soils are currently used for grain crop production.

In a representative profile of Druxman soil the solum is approximately 50 cm thick. The profile is characterized by a very dark gray Ah or Ap horizon, 15 to 25 cm thick, a dark yellowish brown to olive brown Bm horizon, 20 to 30 cm thick with many, fine, distinct, yellowish brown iron mottles, a transitional dark yellowish brown BC, 5 to 10 cm thick, occasionally a yellowish brown IICca horizon, 5 to 10 cm thick and light yellowish brown IICk horizon with many, large prominent iron mottles.

Druxman soils occur in close association with Croyon and Carvey soils. They are similar to Capell soils by having an imperfectly drained Black profile developed on loamy over sandy-skeletal deposits but differ from Capell soils because Capell soils lack a Bm horizon. Druxman soils were previously mapped as imperfectly drained associates of the Marringhurst Association in the reconnaissance soil survey of the Rossburn-Virden Report (1956).

Eroded Slope Complex (ERX)

This soil complex includes all the land occupied by the eroded slopes of river valleys and walls, incised stream channels and ravines that have down-cut through the surface deposits and shale bedrock. These are generally well drained, strongly to steeply sloping landforms that have variable soil development on materials that are variable in composition, depending on the nature of the surrounding deposits. Due to its complexity, this is a miscellaneous land type rather than a unit of normal soil. These areas are typically influenced by mass wasting processes such as slump, creep, solifluction and erosion.

In the study area the soils range from Orthic Blacks to Regosols. The materials are largely shallow lacustrine and fluvial materials over glacial till which are often subsequently deposited as colluvium along the slopes. Shale bedrock may occur in the mid to lower slope positions. The slopes are characterized by seepage zones where the water table intersects the slope walls or scarps, generally in the mid to lower slopes. The maintenance of vegetation on the Eroded Slopes is essential for their stability.

Jaymar (JAY)

The Jaymar series consists of well drained, Orthic Black soils developed on a stratified materials composed of a thin mantle (40 to 70 cm) of moderately to strongly calcareous, loamy (L, CL), lacustrine sediments over a thin 30 to 60 cm, contact zone of sandy skeletal (S, GrS) materials, overlying moderately to strongly calcareous, loamy (L, CL, SiCL), glacial till of shale, limestone and grantic rock origin. The soils occur on very gently to gently sloping topography, runoff is moderate, permeability is moderate to rapid in the upper loamy and sandy skeletal strata and moderately slow in the underlying till. These soils are often stony due to the modification of the till.

The soil is characterized by a very dark gray Ah horizon 10 to 15 cm thick, a dark brown to brown Bm horizon 8 to 15 cm thick and a lime accumulation layer (Cca) that occurs at the contact of the loamy sediments and underlying coarser wash zone.

Jaymar soils occur in close association with the Clementi soils. The soils are similar except that the Jaymar series has in addition a sand and gravel layer between the overlay and underlying till.

Levine Series (LEI)

The Levine series consists of imperfectly drained Gleyed Cumulic Regosol soil developed on moderately to strongly calcareous, deep, stratified, coarse loamy to fine loamy (VFSL, L, CL) recent alluvial deposits. These soils occur in flood plains on very gentle slopes. They have moderate permeability, moderately slow surface runoff and a medium water table during the growing season. Levine soils are occasionally slightly saline and are subject to periodic inundation during spring runoff or after heavy rains. They have a moderate to low available water holding capacity, low organic matter content and medium natural fertility.

In a representative profile of Levine soil the solum is approximately 15 cm thick. The profile is characterized by a dark gray Apk or Ahk horizon 10 to 20 cm thick and a light yellowish brown Ck horizon. The underlying strata may vary in colour from light to dark. The thin dark colored mineral and organic layers are former surface horizons that have been exposed to soil forming processes for a significant period before burial by alluvial deposits. Medium, distinct yellowish brown iron mottles occur through the soil.

Levine soils were previously mapped as inclusions of the Assiniboine Complex in the reconnaissance soil survey of the Rossburn-Virden Report.

Marringhurst Series (MRH)

The Marringhurst series consists of moderately well to well drained Calcareous Black soil developed on moderately strongly to strongly calcareous, stratified, deep, sandy (CS,S,LS) and sandy skeletal (GrS,GrCS) glaciofluvial deposits.

These soils occur in upper positions of very gentle slopes on rolling to irregular landscapes and have very rapid permeability, moderate to rapid surface runoff, and a low water table during the growing season. Marringhurst soils are often slightly eroded, non-stony, and non-saline. They have a low available water holding capacity, low organic matter content, and low natural fertility. Native vegetation includes shrubs, bur oak, and prairie grasses. The majority of these soils are currently excavated for gravel or used for grazing.

In a representative profile of Marringhurst soil the solum is approximately 25 cm thick. The profile is characterized by a very dark gray to very dark grayish brown Ah horizon, 14 to 18 cm thick, a dark brown to brown Bmk horizon, 10 to 18 cm thick, a Cca horizon, 20 to 30 cm thick with coarser gravelly strata and a Ck horizon.

Marringhurst soils occur in close association with Dorset, Dexter and Fortina soils. They are similar to Dorset soils by having well drained profile in sandy skeletal deposits but differ from them in having a Bmk rather than Bm horizon. Marringhurst soils were previously mapped as the dominant associate of the Marringhurst Association in the Rossburn-Virden soil report.

Marsden Series (MDN)

The Marsden series consists of poorly drained Rego Humic Gleysol, carbonated soils developed on a sequence of strata consisting of a thin lacustrine mantle (25 to 60 cm) of moderately to strongly calcareous loamy sediments (VFSL to SiCL) over thin (10 to 40 cm) of medium sand to gravel strata over strongly calcareous loam to clay loam glacial till of shale, limestone and granitic origin. The topography is level to depressional; runoff is negligible, and permeability is restricted during periods when free water is at or near the surface.

The soils is characterized by a thin, moderately decomposed organic layer, 1 to 4 cm, a very dark gray Ah horizon, 12 to 18 cm and an olive gray ACKg horizon with yellowish brown mottles. A lime carbonate horizon is usually present at or above the contact of the gravel strata.

Marsh Complex (MHC)

The Marsh complex consists of very poorly drained, Rego Gleysol carbonated soils developed on lacustrine, fluvial and till deposits. These soils occur on level to depressional areas that are covered with water and are usually saturated for most of the year. The native vegetation consists entirely of reeds and sedges.

These soils have a thin surface layer of either muck or mineral material high in organic matter content and are underlain by strongly gleyed, olive gray mineral materials. A very thin Ahg horizon, less than 2.5 cm thick, may be present below the muck surface layer.

Marsh soils are undifferentiated with respect to texture and composition of their parent material. They also are more poorly drained than other Gleysolic soils.

Melland Series (MXT)

The Melland series consists of imperfectly drained, Gleyed Rego Black carbonated soils developed on a sequence of materials consisting of a thin mantle (25 to 60 cm) of moderately to strongly calcareous, loamy

(VFSL to SiCL) sediments over a thin (10 to 40 cm) layer of medium sand to gravel strata over strongly calcareous loam to clay loam glacial till of shale, limestone, and granitic origin. Topography is level to gently sloping; runoff is moderately slow; permeability is moderate in the upper strata, but restricted above the till due to perched water conditions. Lateral flow of water occurs through the gravel strata during the spring or following heavy rains.

The soil is characterized by a very dark gray Ah horizon 18 to 25 cm thick, and a dark gray to grayish brown ACk horizon, 10 to 15 cm thick. A lime accumulation horizon is usually present at the transition from loamy to gravel strata. Melland soils are more permeable than the very similar, finer textured Beresford series.

Miniota Series (MXI)

The Miniota series consists of moderately well to well drained Orthic Black soils developed on a thin mantle (<1 m) of moderately to strongly calcareous very fine sand to fine sandy loam textured sediments over moderately to strongly calcareous, medium sand to gravelly textured deposits. The topography varies from gently sloping to irregular, moderately rolling. They occur in close association with the imperfectly drained Wytonville and Kilmury soils and the poorly drained Bornett series. Runoff is moderate to moderately rapid, and permeability is rapid in the sandy strata and very rapid in the lower coarser strata.

The soil is characterized by a very dark gray to very dark grayish brown Ah horizon, 12 to 20 cm thick, a dark brown to brown Bm horizon, 10 to 18 cm thick, and a pale brown BCk horizon. The depth of solum varies with the depth of the sandy strata; a lime accumulation horizon usually occurs at the transition from sandy to coarser sediments. Miniota soils are less permeable and less droughty than the very similar coarser textured Wheatland and Dorset soils. The similar finer textured Croyon soils are less droughty.

Newdale Series (NDL)

The Newdale series is characterized by an Orthic Black solum on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granitic and shale origin. These soils are moderately well to well drained and occur in mid to upper slope positions of undulating to hummocky landscapes. Surface runoff is moderate to moderately rapid; permeability is moderately slow. Most of these soils are presently cultivated; they have formed under intermixed aspen grove and grassland vegetation.

The Newdale solum has a very dark gray Ah horizon, commonly 25 cm thick and ranging from 15 to 35 cm, a dark brown Bm horizon, 10 to 30 cm thick, and a transitional BC horizon, 3 to 15 cm thick. A lime carbonate horizon, 10 to 15 cm thick is often present in shallower soils but is not evident in deeper profiles. Its solum depth averages 58 cm and ranges from 25 to 90 cm. Minor amounts of well drained Eluviated Black soils are included within the Newdale mapping units. They have solum thickness ranging from 75 cm to greater than 1 m. They also have thicker A (combined Ah, Ahe) horizons, 30 to 60 cm and Bt horizons that are 40 cm thick.

The Newdale soils in the study area differ from Erickson soils in being less strongly leached and having a less distinct and shallower solum. Newdale soils, on the other

hand, differ from the very similar Rufford and Cordova soils in being more strongly leached, deeper and free of lime carbonate in the A and B horizons.

Penrith Series (PEN)

The Penrith series is characterized by a Humic Luvic Gleysol solum developed on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granitic and shale rock origin. These soils are poorly drained and occur in depressional positions of undulating to hummocky landscapes. These soils are ponded for a variable period in the spring and early summer; they usually are free of water in the summer and fall, unless replenished by heavy rains and runoff. Permeability is very slow within the solum and moderately slow in the subsoil. Vegetation consists of sedge and ringed with willow.

The solum of the Penrith series commonly has a moderately to strongly decomposed organic layer, 4 to 8 cm thick, a dark gray to gray Ahe horizon, 6 to 10 cm thick, a light gray, platy Aeg horizon, 6 to 10 cm thick, a dark gray to gray Btg horizon, 35 to 45 cm thick, and a gray transitional BC, 15 to 25 cm thick. In the study area, the A horizon thickness averages 22 cm and ranges from 5 to 45 cm; the average solum depth is 77 cm and ranges from 30 to 105 cm. These soils differ from the Drokan soils in being more strongly leached and having more distinct and thicker horizons.

Rufford Series (RUF)

The Rufford series is characterized by a Rego Black solum on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granitic and shale origin. These soils are moderately well to well drained and occur on the upper slopes and knoll positions in undulating to hummocky landscapes in close association with Cordova and Newdale soils. Runoff is moderately rapid to rapid; permeability is moderately slow.

Rufford profiles commonly have a very dark gray to very dark grayish brown Ah horizon, 12 to 18 cm thick and a thin AC horizon, 6 to 10 cm thick. A lime accumulation layer, 5 to 15 cm thick, is usually present. In the study area, the A horizon averages 28 cm and ranges from 10 to 50 cm; the solum depth averages 37 cm and ranges from 20 to 55 cm.

Rufford soils differ from Cordova soils in being less leached and having thinner, less distinct horizons. Both Rufford and Cordova differ from Newdale in being less leached and having free lime carbonate in their A and B horizons.

Varcoe Series (VRC)

The Varcoe series is characterized by a Gleyed Rego Black (carbonated) solum on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granitic and shale origin. These soils are imperfectly drained and occur in the lower slope positions of undulating to hummocky landscapes in close association with Angusville soils. They receive runoff from the upper slopes, and in some landscapes, may be influenced by seepage. Permeability is slow and may be restricted during periods of subsoil saturation. In areas where upward groundwater or seepage waters

contain appreciable salts, accumulation of salts may occur within the soil.

Varcoe profiles average 42 cm in thickness and range from 20 to 60 cm. The A horizon is usually 28 cm thick and ranges from 20 to 50 cm; very dark gray in color and is underlain by a dark gray transitional AC horizon, 4 to 8 cm thick. A lime accumulation horizon is commonly present, but may be discontinuous. Gypsum crystals are usually present below and within the lime accumulation layer. Varcoe soils containing significant soluble salts in the A horizon as well as gypsum, have been identified as the saline phase of the series.

Vodroff Series (VFF)

The Vodroff series consists of poorly drained Rego Humic Gleysol soils developed on a thin mantle (<1 m) of loamy (L, CL, SiCL) lacustrine sediments over a strongly calcareous loam to clay loam glacial till of shale, limestone and granitic origin. These soils have free water at or near the surface for a considerable period of the year. The topography is level to depressional; runoff is negligible; permeability is restricted during periods of free water within a meter. In areas where the inflowing waters contain appreciable soluble salts, the salt may accumulate in the soil in sufficient amounts to affect the growth of normal hydrophytic vegetation.

The soil is characterized by a moderately decomposed organic layer, 2 to 5 cm thick, a very dark gray Ah horizon, 10 to 18 cm thick, a mottled dark gray ACk horizon, 4 to 8 cm thick and a lime accumulation horizon, 8 to 12 cm thick. The C horizon is olive to pale olive and usually contains yellowish brown mottles.

PART 4

USE AND MANAGEMENT INTERPRETATIONS OF SOILS

4.1 INTRODUCTION

This section provides predictions of performance or soil suitability ratings for various uses of soils based on field observations of soil and landscape characteristics, laboratory data and on observations of soil behavior under specified conditions of land use and management. Suitability ratings or interpretations are intended only to serve as guides for planners and managers. Caution, with an understanding of the limitations of the soil map must be exercised when applying suitability ratings to soil map units. The value of any rating or interpretation depends upon the nature and composition of individual map unit delineation which in turn depends on the scale of mapping and intensity of ground truthing employed in the survey.

In this section, interpretive soil information is provided for the following land use evaluations:

1. Agriculture
   a) dryland farming capability
   b) irrigation suitability
2. Engineering Uses
3. Recreation Uses

4.2 SOIL CAPABILITY FOR AGRICULTURE

Dryland Agriculture

Soil capability classification for dryland agriculture is based on an evaluation of both internal and external soil characteristics that influence soil suitability and limitations for agricultural use. In this classification, mineral soils are grouped into capability classes, subclasses and units based on their limitations for dryland farming, risk of damage when the soils are used and the way they respond to management[7]. There are seven capability classes, each of which groups soils together that have the same relative degree of limitation or hazard for agricultural use. The limitation becomes progressively greater from Class 1 to Class 7. The class indicates the general suitability of the soils for agriculture. The first three classes are considered capable of sustained production of common field crops, the fourth is marginal for sustained arable culture, the fifth is suitable only for improved permanent pasture, the sixth is capable of use only for native pasture while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture.

---

[7] Anon. 1965. Land capability classification for agriculture Report No. 2, Canada Land Inventory, Canada Dept. Regional Economic Expansion, Ottawa. 16 pp.

Organic soils within the map area are rated for "potential" agricultural capability after the method of Leeson[8]. Capability ratings of organic soils for agriculture must recognize that most organic soils have little or no value for agriculture in their native state and their potential is only achieved through reclamation or development implemented with varying degrees of difficulty. Capability class definitions for organic soils are the same as for mineral soils. They are however, identified on maps and tables with the prefix "O".

Soil Capability subclasses are divisions within classes which group soils with similar kinds of limitations and hazards for agricultural use. The various kinds of limitations recognized at the subclass level are defined in Table 4.

Soil capability units are divisions within the subclass category that groups soils together that will respond similarly to a given management input.

A summary of the soils in the study area showing their major characteristics and their interpretive classification for dryland agriculture is presented in Table 5.

---

[8] Leeson, Bruce et al. 1969. An organic soil capability classification for agriculture and a study of the organic soils of Simcoe County, Soil Sci. Dept., Ontario Agricultural College, Guelph, Ontario.

Definitions of the Agricultural Capability Classes

Class 1

Soils in this class have no important limitations for crop use. The soils have level or gently sloping topography; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility; soils are moderately high to high in productivity for a wide range of cereal and special crops.

Class 2

Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3

Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. The limitations include one or more of the following: moderate climatic limitation, erosion, structure or permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water to plants, stoniness and depth of soil to consolidated bedrock. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops.

Class 4

Soils in this class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops, or the yield for a range of crops may be low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a specially adapted crop. The limitations include the adverse effects of one or more of the following: climate, accumulative undesirable soil characteristics, low fertility, deficiencies in the storage capacity or release of soil moisture to plants, structure or permeability, salinity, erosion, topography, overflow, wetness, stoniness, and depth of soil to consolidated bedrock.

Class 5

Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. These soils have such serious soil, climatic or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing and water control.

Some soils in Class 5 can be used for cultivated field crops provided unusually intensive management is used. Some of these soils are also adapted to special crops requiring soil conditions unlike those needed by the common crops.

Class 6

Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery, or because the soils are not responsive to improvement practices, or because stock watering facilities are inadequate.

Class 7

Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

TABLE 4

Agricultural Capability Subclass Limitations

C - Adverse climate: This subclass denotes a significant adverse climate for crop production as compared to the "median" climate which is defined as one with sufficiently high growing season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

D - Undesirable soil structure and/or low permeability: This subclass is used for soils difficult to till, or which absorb water very slowly or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

E - Erosion: Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

F - Low fertility: This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates or presence of toxic compounds.

I - Inundation by streams or lakes: This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

L - Coarse wood fragments: In the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

M - Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

N - Salinity: Designates soils which are adversely affected by the presence of soluble salts.

P - Stoniness: This subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

R - Consolidated bedrock: This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 1 meter from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

T - Topography: This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

W - Excess water: Subclass W is made up of soils where excess water other than that brought about by inundation is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

X - Cumulative minor adverse characteristics: This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not serious enough to affect the class rating.

Irrigation Suitability

Irrigation suitability of soils is determined by evaluating the nature of both internal and external soil characteristics[9]. The classification of soils for irrigation suitability consists of three categories: class, subclass and unit.

The suitability class groups soils having the same relative suitability or degree of limitation or hazard for irrigation use. Four classes are utilized grading from Class 1, which is very good to Class 4, which is poor. The four classes are:

Class 1 - Very good: These are soils of fine sandy loam to clay loam texture which are well suited for irrigation use. The soils have good water retention capacity, good permeability, low salt content, good drainage and low general gradient of land surface.

Class 2 - Good: These are soils of loamy fine sand to light clay texture which are moderately well suited for irrigation use. Slight limitation to use results from soil factors such as water holding capacity, permeability, depth of material, salt content, topographic factors such as slope and pattern or drainage restrictions arising from surface drainage and depth to water table.

Class 3 - Fair: These are coarse or fine textured soils which are fair to marginally suitable because of some unfavorable characteristics that limit production and cause management problems under irrigation use. Soil, topographic or drainage factors are more restrictive than in Class 2.

Class 4 - Poor: These are soils that are considered poor to unsuitable for irrigation use because of severe drainage problems, impermeable geologic material, salinity, very low water holding capacity, very rapid permeability, topography or a combination of these problems.

The suitability subclass identifies soils with similar kinds of limitations and hazards related to both internal and external soil characteristics. The internal characteristics include both permanent and non-permanent properties; the permanent properties are those that will not change over time whereas the non-permanent properties may be altered with time by specific management. The properties which affect irrigation suitability of soil are listed as follows:

1. Internal Characteristics

   a) Permanent - Texture, uniformity and depth of geologic deposit, hydraulic conductivity and water storage capacity

   b) Non-permanent - Structure, drainage, fertility, reaction, salinity, exchangeable sodium

2. External Characteristics

---

[9] PFRA. 1964. Handbook for the classification of irrigation land in the prairie provinces. Prepared by Committee of the Canada Dept. of Agriculture. PFRA, Regina, Sask. 92 pp.

a) Topography, erosion, stoniness, vegetative cover

The classification criteria for irrigation suitability are summarized in Table 11, Appendix B. The soils of the Study areas are evaluated for irrigation suitability in Table 5.

TABLE 5. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability (11)
ANL	Angusville	2W	3SD
ANL /xcxx	Angusville	2T	3SD
ANL /xxxs	Angusville	2N	3SD
ANL /xx4x	Angusville	4P	4S
BKR	Basker	5I	4D
BKR /xcxx	Basker	5I	4D
BSF	Beresford	2W	3SD
BSF /xx1x	Beresford	2W	3SD
BSF /xcxx	Beresford	2T	3SD
BSF /xc1x	Beresford	2T	3SD
BSF /xxxs	Beresford	3N	3SD
BSF /xcxs	Beresford	3N	3SD
BSF /xc1s	Beresford	3N	3SD
BSF /xxxt	Beresford	4N	4S
BSF /xc2x	Beresford	2T	3SD
BSF /xc3x	Beresford	3P	3SD
BSF /xc4x	Beresford	4P	4S
CAV	Carvey	4W	4D
CBF	Cobfield	2W	3SD
CBF /xc2x	Cobfield	2T	3SD
CBF /xc3x	Cobfield	3P	3SD
CBF /xcxs	Cobfield	3N	3SD
CLN	Clementi	1	3S
CLN /xc1x	Clementi	2T	3S
CLN /xc2x	Clementi	2T	3S
CLN /xc3x	Clementi	3P	3S
CLN /xdxx	Clementi	3T	3ST
CLN /xd1x	Clementi	3T	3ST
CLN /1d2x	Clementi	3T	3ST
CLN /xd4x	Clementi	4P	3ST
CLN /xe2x	Clementi	4T	4T
CLN /xe3x	Clementi	4T	4T
CVA	Cordova	2X	3S
CVA /xcxx	Cordova	2T	3S
CVA /xd1x	Cordova	3T	3ST
CXT	Capell	2W	2SD
CXT /xxxa	Capell	3N	3SD
CXW	Chater	4M	3S
CXW /1d1x	Chater	4M	3S
CXW /xc2x	Chater	4N	3SD

TABLE 5. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability (11)
CYN	Croyon	3M	2S
CYN /xc1x	Croyon	3M	2ST
CYN /xc2x	Croyon	3M	2ST
CYN /xdxx	Croyon	3MT	3T
CYN /xd2x	Croyen	3T	3T
CYN /xd4x	Croyon	4P	4S
CYN /xd5x	Croyon	5P	4S
DOT	Dorset	5M	4S
DOT /xx1x	Dorset	5M	4S
DOT /xc1x	Dorset	5M	4S
DOT /xc2x	Dorset	5M	4S
DOT /xdxx	Dorset	5M	4S
DOT /xd1x	Dorset	5M	4S
DOT /1d1x	Dorset	5M	4S
DOT /xd2x	Dorset	5M	4S
DOT /1e2x	Dorset	5M	4S
DRO	Drokan	5W	4DS
DRO /xx1x	Drokan	5W	4DS
DRO /xxxs	Drokan	5W	4DS
DRO /xx1s	Drokan	5W	4DS
DRO /xx2s	Drokan	5W	4DS
DRO /xxxt	Drokan	5W	4DS
DXM	Druxman	2M	2ST
DXM /xx1x	Druxman	2M	2ST
ERX	Eroded Slope Compl	6T	4T
JAY	Jaymar	3M	2S
JAY /xc1x	Jaymar	3M	2ST
JAY /xc2x	Jaymar	3M	2ST
JAY /xx3x	Jaymar	3P	3S
JAY /xc3x	Jaymar	3P	3T
JAY /xc4x	Jaymar	4P	4S
JAY /xc5x	Jaymar	5P	4S
JAY /1c2x	Jaymar	3M	2ST
JAY /xdxx	Jaymar	3MP	3P
JAY /1d1x	Jaymar	3MT	3T
JAY /xd4x	Jaymar	4P	4S
JAY /xd5x	Jaymar	5P	4S
LEI	Levine	4M	3D
LEI /xcxx	Levine	6M	3D
MDN	Marsden	5M	4D

TABLE 5. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability (11)
MDN /xxxs	Marsden	5W	4DS
MDN /xxls	Marsden	5W	4DS
MDN /xxlt	Marsden	5W	4DS
MHC	Marsh Complex	7W	4D
MRH	Marringhurst	5M	4S
MXI	Miniota	4M	2S
MXI /xxlx	Miniota	4M	2S
MXI /xcxx	Miniota	4M	2T
MXI /xclx	Miniota	4M	2ST
MXT	Melland	2W	3SD
MXT /xxlx	Melland	2W	3SD
MXT /xcxx	Melland	2W	3SD
MXT /xclx	Melland	2W	3SD
MXT /xxlt	Melland	4M	4S
MXT /xc2x	Melland	2T	3SD
MXT /xx2x	Melland	2W	3DS
MXT /xx3x	Melland	3P	3SD
MXT /xc3x	Melland	3P	3SD
MXT /xc4x	Melland	4P	4S
NDL	Newdale	2X	3S
NDL /xcxx	Newdale	2T	3S
NDL /xclx	Newdale	2T	3S
NDL /lcxx	Newdale	2T	3S
NDL /lclx	Newdale	2T	3S
NDL /xdxx	Newdale	3T	3ST
NDL /ldxx	Newdale	3T	3ST
NDL /xdlx	Newdale	3T	3ST
NDL /ldlx	Newdale	3T	3ST
NDL /xd2x	Newdale	3T	3ST
NDL /ld2x	Newdale	3T	3ST
NDL /2d3x	Newdale	3T	3ST
PEN	Penrith	5W	4DS
RUF	Rufford	2X	3S
RUF /xdlx	Rufford	3T	3ST
RUF /ldxx	Rufford	3T	3ST
RUF /ldlx	Rufford	3T	3ST
VFF	Vodroff	5W	4D
VFF /xxxs	Vodroff	5W	4D
VFF /xxls	Vodroff	5W	4D
VRC	Varcoe	2W	3SD

TABLE 5. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability (11)
VRC /xcxx	Varcoe	2T	3SD
VRC /xxxs	Varcoe	3N	3SD
VRC /xxls	Varcoe	3N	3SD
VRC /xcxs	Varcoe	3N	3SD
VRC /xcls	Varcoe	3N	3SD
VRC /xx?s	Varcoe	3N	3SD
VRC /xxxt	Varcoe	4N	4SD

4.3 SOIL SUITABILITY FOR SELECTED ENGINEERING USES

This section provides information which can be used by engineers and land use planners concerned with engineering and related geotechnical aspects of soil. It is intended to supplement the information on the soil map with additional data on engineering properties of soils.

The criteria used to evaluate soil suitability for selected engineering and related recreational uses are adopted from guides found in Coen et al[10]. and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture[11] and the Canada Soil Survey Committee[12].

Definition of Soil Suitability Classes

Evaluation of soil suitability for engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soils and hence, mapping units for selected uses. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long term effects of the potential use on the behavior of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

Good - Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.

Fair - Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.

Poor - Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require the removal of the limitation or difficult and costly alteration of the soil or of special design or intensive maintenance.

Very Poor - Soils have one or more features so unfavorable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

---

[10] Coen et al. 1977. Soil Survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37. 208 pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

[11] USDA. 1971. Guide for Interpreting Engineering Uses of Soils. Soil Conservation Service, USDA. SCS-45. 87 pp.

[12] CSSC. 1973. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, University of Saskatchewan, Saskatoon. 357 pp.

Soil Suitability Subclasses

The basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering properties and recreation uses are provided in Table 6. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

Guides for Assessing Soil Suitability

Guides for assessing soil suitability for ten engineering related uses are given in Appendix B, Tables 12 to 21. These tables provide as specifically as possible, definitions of the soil properties which result in the specific suitability or degree of limitation. In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very Poor", then the overall rating of the soil for that selected use is "Very Poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

Engineering description of the soils and their estimated properties significant to engineering are provided in Table 7. These data, in addition to information contained in other sections of the report have been used to rate the soils according to their suitability for ten selected engineering uses in Table 8. When using these interpretations, consideration must be given to the following assumptions:

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management as specified in the preamble to each of Tables 12 through 25 (Appendix B).

2. Soil ratings do not include site factors such as nearness to towns and highways, water supply, aesthetic values, etc.

3. Soil ratings are based on natural, undisturbed soil.

4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.

5. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify the soil limitations. The use of soils rated as poor depends on the nature of the limi-

tations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.

6. Interpretations of map units do not eliminate the need for on-site evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for or importance of on-site studies depends on the use to be made of the soil and the kinds of soil and soil problems involved.

4.4 SOIL SUITABILITY FOR SELECTED RECREATION USES

This section provides interpretations of the soil suitability for recreational development. All types of soil can be used for recreational activities of some kind.

Soils and their properties determine to a large degree, the type and location of recreational facilities. Wet soils are not suitable for campsites, roads, playgrounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is contemplated. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by other basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The suitability of the various soil series and phases for selected recreation uses is shown in Table 9 according to four classes, Good, Fair, Poor and Very poor defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols are provided in Table 6.

The guidelines for various recreation uses are presented in Appendix B, Tables 22 to 25 and 15.

TABLE 6

Codes utilized to identify limitations in evaluating soil suitability for selected Engineering and Recreational Uses(Tables 8 and 9)

a subgrade properties

b thickness of topsoil

c coarse fragments on surface

d depth to bedrock

e erosion or erodibility

f susceptibility to frost hazard

g contamination hazard of groundwater

h depth to seasonal water table

i flooding or inundation

j thickness of slowly permeable material

k permeability or hydraulic conductivity

l shrink-swell properties

m moisture limitations or deficit

n salinity or sulphate hazard

o organic matter

p stoniness

q depth to sand or gravel

r rockiness

s surface texture

t topographic slope class

u moist consistence

w wetness or soil drainage class

z permafrost

Table 7. Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed Hydraulic Conductivity (cm/hr)	Reaction (pH)	Sulfate-Hazard*	Dispersion	Shrink-Swell Poten.	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
ANL	Angusville	30-70	CL-C	CH	A-7 6	95-100	90-100	75-90	<.15	6.6-7.4	low	low	high	0.9
		70-120	L-CL	CL	A-6	85-95	80-90	60-75	.15-1.5	7.8-8.2	low	low	mod.	
BKR	Basker	0-20	SiL-SiCL	ML to CL	A-6,A-7	100	100	95-100	.5-2.0	7.6-8.0	low	low	mod.	at or near surface-subject to flood
		20-60	strat. FSL-SiL CL	ML to CL	A-4,A-7-6	100	100	65-100	-	7.8-8.2	low	low	mod.	
		60-100	strat. SiL-SiCL	ML to CL	A-4,A-7-6	100	100	75-100	-	7.8-8.2	low	low	mod.	
BSF	Beresford	0-30	CL	CL	A-6	100	100	75-85	1.5-2.5	7.4-7.8	low	low	high	seasonal 0.6
		30-60	SiCL-CL	ML to CL	A-4,A-6	85-95	75-85	60-75	<.25	7.8-8.2	mod.	mod.	mod.	
		60-100+	L-CL	CL	A-4,A-6	85-90	55-75	40-60	<.1	7.8-8.2	high	mod.	mod.	
CAV	Carvey	0-25	SCL-L	SC or CL	A-4,A-6	100	80-95	40-75	-	7.8-8.2	low-mod.	low	mod.	seasonal at or near surface
		25-50	SL-L	SM or CL	A-4,A-6	100	60-95	35-75	-	7.8-8.4	low-mod.	low	mod.	
		50-100	CS-GrS	SP or GW	A-1	var.	<60	<5	-	7.8-8.4	low-mod.	low	low	
CBF	Cobfield	0-15	L-CL	CL	A-6	100	100	65-85	1.5-5.0	7.3-7.8	low	low	mod.	<1.5
		15-50	L-CL	CL	A-6	100	100	65-85	1.5-5.0	7.6-8.0	low	low	mod.	
		50-80	L-SiCL	CL-ML	A-4	90-100	80-95	60-90	0.5-1.5	7.8-8.4	low	low	mod.	
		80-100+	L-CL	CL	A-6,A-4	85-90	55-80	40-70	<0.25	7.8-8.4	mod.	mod.	mod.	
CLN	Clementi	0-40	L-CL	CL	A-6	100	100	75-85	1.5-2.5	7.2-7.6	low	low	mod.	>1.5
		40-70	SiCL	ML to CL	A-4,A-6	85-90	75-85	60-75	.5-2.0	7.8-8.4	low	low	mod.	
		70-100+	L-CL	CL	A-4,A-6	85-90	55-75	40-60	<.25	7.8-8.2	low-mod.	low	mod.	
CVA	Cordova	30-120	L-CL	CL	A-6	85-95	75-90	60-75	.15-1.5	7.8-8.2	low	low	mod.	>2
CXT	Capell	0-20	SCL-L	CL	A-6,A-7-5	95-100	85-95	40-55	1.5-5.0	7.6-8.0	low	low	mod.	seasonal 0.8
		20-40	SCL-L	SC or CL	A-6,A-4	95-100	85-95	30-50	1.5-5.0	7.8-8.2	low	low	mod.	
		40-70	Gr-SL	SM	A-1,A-2	-	<50	15-30	25.0-50.0	7.8-8.2	low	low	low	
		70+	GrS	SP or GP	A-1	-	<45	<5	>50.0	7.8-8.2	low	low	low	
CXW	Chater	0-15	LMS-SL	SM	A-2	75-95	50-90	10-20	>25.0	7.6-8.0	low	low	low	>1.5
		15-70	S-Gr	GW to GP	A-1	-	-	2-5	>25.0	7.8-8.2	low	low	low	
		70-90	SiCL-L	CL to ML	A-4	85-95	80-90	60-75	0.5-1.5	7.8-8.4	low	low	mod.	
		90+	L-CL	CL	A-6,A-4	85-90	55-75	40-60	<0.25	7.8-8.4	low	low	mod.	
CYN	Croyon	0-25	SCL-L	CL	A-6	100	85-95	60-80	1.5-5.0	7.2-7.8	low	low	mod.	
		25-50	L-CL	CL	A-6	90-100	60-95	35-75	1.5-5.0	7.8-8.2	low	low	mod.	>2
		50-100+	CS-GrS	SP	A-1	-	<20	<5	>25.0	7.8-8.2	low	low	low	
DOT	Dorset	0-20	LFS-LS	Sp	A-2	100	90-100	10-35	15-25	7.0-7.4	low	low	low	
		25-50	GrLS-GrS	GP-SP	A-1	35-60	30-50	<5	>25	7.4-7.8	low	low	low	>2
		50-100	S-Gr	GP-SP	A-1	35-60	20-30	<5	>25	7.8-8.2	low	low	low	
DRO	Drokan	30-120	CL	CL	A-6	85-95	75-90	60-75	<.15	7.8-8.2	mod.	mod.	mod.	at surface and ponding
DXM	Druxman	0-20	L-CL	CL	A-4,A-6	100	90-100	70-90	1.5-5.0	7.0-7.4	low	low	mod.	
		20-55	L-SiL	ML	A-4,A-6	100	90-100	70-90	1.5-5.0	7.6-8.0	low	low	mod.	>2
		55-80	LS	SM	A-2-4	var.	<60	15-25	12.5-25	7.6-8.2	low	low	low	
		80-100+	S-Gr	Sp	A-1,A-2	var.	<60	<5	>25	7.8-8.2	low	low	low	
ERX	Eroded Slopes Complex	30-120	L-CL	CL	A-6	80-90	70-90	-	.05-.5	7.8-8.2	low	low	mod.	possible seepage at lower slopes

Table 7. Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses (continued)

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed Hydraulic Conductivity (cm/hr)	Reaction (pH)	Sulfate-Hazard*	Dispersion	Shrink-Swell Poten.	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
JAY	Jaymar	0-40	SL-L	ML to CL	A-6	85-95	75-90	35-70	1-5	7.3-7.8	low	low	mod.	
		40-80	GrS	Gp to Sp	A-1	-	<10	<5	>25	7.8-8.2	low	low	low	>2
		80-100	L-CL	CL	A-6,A-4	80-90	60-80	50-70	.1-.5	7.8-8.4	low	low	mod.	
LEI	Levine	0-20	VFSL-L	ML to CL	A-4,A-7-6	100	100	65-100	1.5-5.0	7.4-7.8	low	low	mod.	seasonal 0.8 subject occa-ional flooding
		20-100	strat. SiL-CL	ML to CL	A-4,A-7-6	100	100	65-100	.5-1.5	7.8-8.4	low	low	mod.	
MDN	Marsden	0-40	SL-L	ML to CL	A-6	85-95	75-90	35-70	<1.5	7.4-7.8	low	low	mod.	at or
		40-85	GrS	Gp to Sp	A-1	-	10-20	5	-	7.8-8.4	low	low	low	near
		85-100	L-CL	CL	A-6,A-4	80-90	60-80	50-75	-	7.8-8.4	mod.	mod.	mod.	surface
MRH	Marring-hurst	0-25	LFS-FSL	SM or SP	A-2-4	100	90-100	10-35	15.0-25.0	7.4-7.8	low	low	low	
		25-55	GrLS-GrS	GP or SP	A-1	35-60	-	<5	>15.0	7.8-8.0	low	low	low	>2
		55-100	S-Gr	GP-or SP	A-1	35-60	-	<5	>20.0	7.8-8.0	low	low	low	
MXI	Miniota	0-20	FSL	ML to SM	A-4,A-6	100	100	45-80	6-12.0	6.5-7.0	low	low	low	1.5
		20-40	VFS-FSL	SM to ML	A-4,A-7-5	100	100	-	2-6	6.5-7.0	low	low	low	
		40-100	S-Gr	GP to Sp	A-1	40-70	-	2-5	>25	7.4-7.8	low	low	low	
MXT	Melland	0-40	SL-L	ML to CL	A-6	85-95	75-90	35-70	1.5-5.0	7.4-7.8	low	low	mod.	seasonal
		40-85	GrS	Gp to Sp	A-1	-	10-20	5	>25	7.8-8.4	low	low	low	0.8
		85-100+	L-CL	CL	A-6,A-4	80-90	60-80	50-75	.1-.5	7.8-8.4	low	low	mod.	
NDL	Newdale	25-65	L-CL	CL	A-6	85-95	75-90	60-75	.15-1.5	6.6-7.4	low	low	mod.	
		65-120	L-CL	CL	A-6	85-95	75-90	60-75	.15-1.5	7.8-8.2	low	low	mod.	>2
PEN	Penrith	30-85	C	CH	A-7-6	100	95-100	75-95	<.15	6.6-7.4	low	low	high	at
		85-120	CL	CL	A-6	85-95	75-90	60-75	.05-.5	7.8-8.2	low	low	mod.	surface
RUF	Rufford	30-120	L-CL	CL	A-6	85-95	75-90	60-75	.15-1.5	7.8-8.2	low	low	mod.	>1.5
VRC	Varcoe	30-75	SiCL-CL	CL to CH	A-6,A-7-6	90-95	85-95	70-85	<.5	7.8-8.2	low	low	mod.	0.8
		75-120	L-CL	CL	A-6	85-95	75-90	60-75	<.15	7.8-8.2	low	low	mod.	
VRC	Varcoe Saline Phase	Similar to above - contains appreciable salts									high	high	mod.	subject to upward flow and seepage
VFF	Vodroff	0-40	CL	CL	A-6	100	100	75-85	<1.5	7.8-8.2	low	low	mod.	at or
		40-70	SiCL-CL	ML to CL	A-4,A-6	85-95	75-85	60-75	-	7.8-8.4	low	low	mod.	near
		70-100	L-CL	CL	A-4,A-6	85-95	55-75	40-60	-	7.8-8.4	mod.	low	mod.	surface
VFF	Vodroff Saline Phase	Similar to above contains salts									high	high	mod.	subject to upward flow of ground-water and seepage

* Permeability of horizons or layers is expressed in cm/hr

very rapid	>25 cm/hr	moderate	2.5-5.0 cm/hr
rapid	15-25 cm/hr	moderately slow	1.5-2.5 cm/hr
moderately rapid	5-15 cm/hr	slow	.125-1.5 cm/hr
		very slow	<.125

* Sulfate Hazard - relative degree of sulfate attack based on criteria established by U.S. Bureau of Reclamation.

TABLE 8. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase		Soil Name	Top Soil (12)	Sand & Gravel (13)	Road Fill (14)	Permanent Bldgs. with Basements (15)	Local Roads and Streets (16)	Sanitary Trench (17)	Landfill Area (18)	Cover Material (19)	Sewage Lagoons (20)	Septic Fields (21)
ANL		Angusville	Fs	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fk	Phk
ANL	/xcxx	Angusville	Fs	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fkt	Phk
ANL	/xxxs	Angusville	Pn	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fk	Phk
ANL	/xx4x	Angusville	Pp	Va	Pp	Pwp	Pp	Pwp	Fw	Pp	Pp	Phk
BKR		Basker	Pi	Va	Pw	Vi	Vi	Vi	Viw	Pw	Vi	Vi
BKR	/xcxx	Basker	Pi	Va	Pw	Vi	Vi	Vhi	Vhi	Pw	Vi	Vhi
BSF		Beresford	Fs	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fk	Phk
BSF	/xx1x	Beresford	Fs	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fk	Phk
BSF	/xcxx	Beresford	Fs	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fkt	Phk
BSF	/xc1x	Beresford	Fs	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fkt	Phk
BSF	/xxxs	Beresford	Pn	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fk	Phk
BSF	/xcxs	Beresford	Pn	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fkt	Phk
BSF	/xc1s	Beresford	Pn	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fkt	Phk
BSF	/xxxt	Beresford	Vn	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fk	Phk
BSF	/xc2x	Beresford	Fsp	Va	Faw	Pw	Faw	Pw	Fw	Fsp	Fkt	Phk
BSF	/xc3x	Beresford	Pp	Va	Fap	Pwp	Fwp	Pwp	Fw	Pp	Fpt	Phk
BSF	/xc4x	Beresford	Pp	Va	Pp	Pwp	Pp	Pwp	Fw	Pp	Pp	Phk
CAV		Carvey	Fs	Fa	Pw	Pw	Pw	Vwg	Vhg	Pw	Vkg	Vhg
CBF		Cobfield	Fs	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fka	Ph
CBF	/xc2x	Cobfield	Fsp	Va	Faw	Pw	Fwa	Pw	Fw	Fsp	Fkt	Phk
CBF	/xc3x	Cobfield	Pp	Va	Fap	Pwp	Fwp	Pwp	Fw	Pp	Fpt	Phk
CBF	/xcxs	Cobfield	Pn	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fkt	Phk
CLN		Clementi	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fk	Pk
CLN	/xc1x	Clementi	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk
CLN	/xc2x	Clementi	Fsp	Va	Fa	Fap	Fa	Fsp	G	Fsp	Fkt	Pk
CLN	/xc3x	Clementi	Pp	Va	Fap	Pp	Fap	Pp	G	Pp	Fkp	Pk
CLN	/xdxx	Clementi	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pp	Pk
CLN	/xd1x	Clementi	Fts	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk
CLN	/1d2x	Clementi	Fpt	Va	Fa	Fap	Fa	Fsp	G	Fsp	Pt	Pk
CLN	/xd4x	Clementi	Pp	Va	Pp	Pp	Pp	Pp	G	Pp	Ppt	Pk

TABLE 8. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase		Soil Name	Top Soil (12)	Sand & Gravel (13)	Road Fill (14)	Permanent Bldgs. With Basements (15)	Local Roads and Streets (16)	Sanitary Trench (17)	Landfill Area (18)	Cover Material (19)	Sewage Lagoons (20)	Septic Fields (21)
CLN	/xe2x	Clementi	Pt	Va	Fa	Fat	Fat	Fsp	Ft	Fst	Vt	Pk
CLN	/xe3x	Clementi	Ptp	Va	Fap	Pp	Fpt	Pp	Ft	Pp	Vt	Pk
CVA		Cordova	Fbs	Va	Fa	Fa	Fa	Fs	C	Fs	Fk	Pk
CVA	/xcxx	Cordova	Fbs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk
CVA	/xd1x	Cordova	Fbt	Va	Fa	Fa	Fa	Fs	C	Fs	Pt	Pk
CXT		Capell	Fbs	G	Fw	Pw	Fwa	Vsk	Vkg	Pq	Vka	Phg
CXT	/xxxs	Capell	Pn	G	Fw	Pwa	Fwa	Vsk	Vkg	Pq	Vka	Phg
CXW		Chater	Pbs	Fa	C	Fa	C	Pkg	Pkg	Pq	Pkg	Fhg
CXW	/1d1x	Chater	Pbs	Fa	C	Fa	C	Pkg	Pkg	Pq	Pkg	Fhg
CXW	/xc2x	Chater	Pbs	Fa	C	Fap	C	Pkg	Pkg	Pq	Pkg	Fhg
CYN		Croyon	Fbs	G	G	G	Fa	Vsk	Vkg	Pq	Vka	Gg
CYN	/xc1x	Croyon	Pbs	G	G	G	Fa	Vsk	Vkg	Pq	Vka	Gg
CYN	/xc2x	Croyon	Fbs	G	G	Fp	Fa	Vsk	Vkg	Pq	Vka	Gg
CYN	/xdxx	Croyon	Fts	G	G	G	Fa	Vsk	Vkg	Pq	Vka	Gg
CYN	/xd2x	Croyon	Ftp	G	G	Fp	Fa	Vsk	Vkg	Pq	Vka	Gg
CYN	/xd4x	Croyon	Pp	Pp	Pp	Pp	Pp	Vsk	Vkg	Pqp	Vka	Gg
CYN	/xd5x	Croyon	Vp	Vp	Vp	Vp	Vp	Vsp	Vkg	Vp	Vkp	Gg
DOT		Dorset	Pbs	G	G	G	G	Vsk	Vkg	Vs	Vak	Gg
DOT	/xx1x	Dorset	Pbs	G	G	G	G	Vsk	Vkg	Vs	Vak	Gg
DOT	/xc1x	Dorset	Pbs	G	G	G	G	Vsk	Vkg	Vs	Vka	Gg
DOT	/xc2x	Dorset	Pbs	G	G	Fp	G	Vsk	Vkg	Vs	Vak	Gg
DOT	/xdxx	Dorset	Pbs	G	G	G	G	Vsk	Vkg	Vs	Vak	Gg
DOT	/xd1x	Dorset	Pbs	G	G	G	G	Vsk	Vkg	Vs	Vak	Gg
DOT	/1d1x	Dorset	Pbs	G	G	G	G	Vsk	Vkg	Vs	Vak	Gg
DOT	/xd2x	Dorset	Pbs	G	G	Fp	G	Vsk	Vkg	Vs	Vak	Gg
DOT	/1e2x	Dorset	Ptb	G	G	Ftp	Ft	Vsk	Vkg	Vs	Vtk	Ft
DRO		Drokan	Fs	Va	Vh	Pw	Pw	Vw	Pw	Pw	C	Vh
DRO	/xx1x	Drokan	Fs	Va	Vh	Pw	Pw	Vw	Pw	Pw	G	Vh
DRO	/xxxs	Drokan	Pn	Va	Vh	Pw	Pw	Vw	Pw	Pw	C	Vh
DRO	/xx1s	Drokan	Pn	Va	Vh	Pw	Pw	Vw	Pw	Pw	C	Vh

TABLE 8. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase		Soil Name	Top Soil (12)	Sand & Gravel (13)	Road Fill (14)	Permanent Bldgs. With Basements (15)	Local Roads and Streets (16)	Sanitary Trench (17)	Landfill Area (18)	Cover Material (19)	Sewage Lagoons (20)	Septic Fields (21)
DRO	/xx2s	Drokan	Pn	Va	Vh	Pw	Pw	Vw	Pw	Pw	G	Vh
DRO	/xxxt	Drokan	Vn	Va	Vh	Pw	Pw	Vw	Pw	Pw	G	Vh
DXM		Druxman	Fs	G	Fw	Pw	Fw	Vsg	Vkg	Pq	Vkg	Phg
DXM	/xx1x	Druxman	Fs	G	Fw	Pw	Fw	Vsg	Vkg	Pq	Vkg	Phg
ERX		Eroded Slope Compl	Vt	Va	Pt	Vt	Vt	Pt	Vt	Vt	Vt	Vt
JAY		Jaymar	Fbs	Paq	Fa	Fa	Fa	Pkg	Pkg	Pq	Pg	Fkg
JAY	/xc1x	Jaymar	Fbs	Paq	Fa	Fa	Fa	Pkg	Pkg	Pq	Pkg	Fkg
JAY	/xc2x	Jaymar	Fbp	Paq	Fa	Fap	Fa	Pkg	Pkg	Pq	Pkg	Fkg
JAY	/xx3x	Jaymar	Pp	Paq	Fap	Pp	Fap	Pkp	Pkg	Pqp	Pkg	Fkg
JAY	/xc3x	Jaymar	Pp	Paq	Fap	Pp	Fap	Pkp	Pkg	Pqp	Pkg	Fkg
JAY	/xc4x	Jaymar	Pp	Pp	Pp	Pp	Pp	Pkp	Pkg	Pqp	Pkp	Fkg
JAY	/xc5x	Jaymar	Vp	Vp	Vp	Vp	Vp	Vp	Pkg	Vp	Vp	Fkg
JAY	/1c2x	Jaymar	Fsp	Paq	Fa	Fap	Fa	Pkg	Pkg	Pq	Pkg	Fkg
JAY	/xdxx	Jaymar	Fst	Paq	Fa	Fa	Fa	Pkg	Pkg	Pq	Pkt	Fkg
JAY	/1d1x	Jaymar	Fst	Paq	Fa	Fa	Fa	Pkg	Pkg	Pq	Ptg	Fkg
JAY	/xd4x	Jaymar	Pp	Pap	Pp	Pp	Pp	Ppg	Pkg	Pqp	Ptp	Fkg
JAY	/xd5x	Jaymar	Vp	Vp	Vp	Vp	Vp	Vp	Pkg	Vp	Vp	Fkg
LEI		Levine	Fis	Va	Faw	Piw	Pi	Pi	Pi	Fs	Vi	Pi
LEI	/xcxx	Levine	Fis	Va	Faw	Piw	Pi	Pi	Pi	Fs	Vi	Pi
MDN		Marsden	Fsb	Pa	Pw	Vh	Pw	Vwg	Vhg	Pw	Vhg	Vhg
MDN	/xxxs	Marsden	Pn	Pa	Pw	Vh	Pw	Vwg	Vhg	Pw	Vhg	Vhg
MDN	/xx1s	Marsden	Pn	Pa	Pw	Vh	Pw	Vwg	Vhg	Pw	Vhg	Vhg
MDN	/xx1t	Marsden	Vn	Pa	Pw	Vh	Pw	Vwg	Vhg	Pw	Vhg	Vhg
MHC		Marsh Complex	Vw	Va	Vw	Vw	Vw	Vw	Vw	Vw	Vh	Vh
MRH		Marringhurst	Psh	G	G	G	G	Vsk	Vkg	Vs	Vk	Gg
MXI		Miniota	Fb	G	G	G	G	Vsk	Pkg	Pq	Vka	Gg
MXI	/xx1x	Miniota	Fb	G	G	G	G	Vsk	Pkg	Pq	Vka	Gg
MXI	/xcxx	Miniota	Fb	G	G	G	G	Vsk	Pkg	Pq	Vka	Gg
MXI	/xc1x	Miniota	Fb	G	G	G	G	Vsk	Pkg	Pq	Vka	Gg
MXT		Melland	Fsb	Pa	Faw	Pw	Fw	Pwg	Pkg	Pq	Pkg	Fkg

TABLE 8. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase		Soil Name	Top Soil (12)	Sand & Gravel (13)	Road Fill (14)	Permanent Bldgs. With Basements (15)	Local Roads and Streets (16)	Sanitary Trench (17)	Landfill Area (18)	Cover Material (19)	Sewage Lagoons (20)	Septic Fields (21)
MXT	/xx1x	Melland	Fsb	Pa	Faw	Pw	Fw	Pwg	Pkg	Pq	Pkg	Fkg
MXT	/xcxx	Melland	Fsb	Pa	Faw	Pw	Fw	Pwg	Pkg	Pq	Pkg	Fkg
MXT	/xc1x	Melland	Fsb	Pa	Faw	Pw	Fw	Pwg	Pkg	Pq	Pkg	Fkg
MXT	/xx1t	Melland	Vn	Pa	Faw	Pw	Fw	Pwg	Pkg	Pq	Pkg	Fkg
MXT	/xc2x	Melland	Fp	Pa	Faw	Pw	Fw	Pwg	Pkg	Pq	Pkg	Fkg
MXT	/xx2x	Melland	Fp	Pa	Faw	Pw	Fw	Pwg	Pkg	Pq	Pkg	Fkg
MXT	/xx3x	Melland	Pp	Pa	Fap	Pwp	Fwp	Pwp	Pkg	Pqp	Pkg	Fkg
MXT	/xc3x	Melland	Pp	Pa	Fap	Pwp	Fwp	Pwp	Pkg	Pqp	Pkg	Fkg
MXT	/xc4x	Melland	Pp	Pap	Pp	Pwp	Pp	Pwp	Pkg	Pqp	Pkp	Fkg
NDL		Newdale	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fk	Pk
NDL	/xcxx	Newdale	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk
NDL	/xc1x	Newdale	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk
NDL	/1cxx	Newdale	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk
NDL	/1c1x	Newdale	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk
NDL	/xdxx	Newdale	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk
NDL	/1dxx	Newdale	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk
NDL	/xd1x	Newdale	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk
NDL	/1d1x	Newdale	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk
NDL	/xd2x	Newdale	Fsp	Va	Fa	Fap	Fa	Fsp	G	Fsp	Pt	Pk
NDL	/1d2x	Newdale	Fst	Va	Fa	Fap	Fa	Fsp	G	Fsp	Pt	Pk
NDL	/2d3x	Newdale	Fp	Va	Fap	Pp	Fap	Pp	G	Pp	Pt	Pk
PEN		Penrith	Fsb	Va	Faw	Pw	Pw	Vw	Pw	Pw	G	Vh
RUF		Rufford	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fk	Pk
RUF	/xd1x	Rufford	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk
RUF	/1d1x	Rufford	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk
RUF	/1d1x	Rufford	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk
VFF		Vodroff	Fs	Va	Fw	Vw	Pw	Vw	Pw	Pw	Fk	Vh
VFF	/xxxs	Vodroff	Fs	Va	Fw	Vw	Pw	Vw	Pw	Pw	Fk	Vh
VFF	/xx1s	Vodroff	Fs	Va	Fw	Vw	Pw	Vw	Pw	Pw	Fk	Vh
WAV		Warroe	Fs	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fk	Pk

TABLE 8. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil (12)	Sand & Gravel (13)	Road Fill (14)	Permanent Bldgs. With Basements (15)	Local Roads and Streets (16)	Sanitary Trench (17)	Landfill Area (18)	Cover Material (19)	Sewage Lagoons (20)	Septic Fields (21)
VRC /xcxx	Varcoe	Fs	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fkt	Pk
VRC /xxxs	Varcoe	Pn	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fk	Pkh
VRC /xx1s	Varcoe	Pn	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fk	Pkh
VRC /xcxs	Varcoe	Pn	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fkt	Pkh
VRC /xc1s	Varcoe	Pn	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fkt	Pkh
VRC /xx2s	Varcoe	Pn	Va	Faw	Pw	Faw	Pw	Fw	Fsp	Fk	Pkh
VRC /xxxt	Varcoe	Vn	Va	Faw	Pw	Faw	Pw	Ph	Fs	Fk	Pkh

TABLE 9. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground (22)	Picnic Area (23)	Camp Area (24)	Path And Trails (25)	Permanent Bldgs. Without Basements (15)
ANL	Angusville	Fws	Fsw	Fws	Fsw	Faw
ANL /xcxx	Angusville	Fwt	Fsw	Fws	Fsw	Faw
ANL /xxxs	Angusville	Pwn	Pwn	Fwn	Fsw	Faw
ANL /xx4x	Angusville	Pp	Pp	Pp	PP	Pp
BKR	Basker	Pi	Vwi	Vwi	Pw	Vh
BKR /xcxx	Basker	Piw	Viw	Viw	Pw	Vi
BSF	Beresford	Fw	Fsw	Fws	Fsw	Faw
BSF /xx1x	Beresford	Fw	Fsw	Fws	Fsw	Faw
BSF /xcxx	Beresford	Fwt	Fsw	Fws	Fsw	Faw
BSF /xc1x	Beresford	Fwt	Fsw	Fws	Fsw	Faw
BSF /xxxs	Beresford	Pwn	Pwn	Pwn	Fsw	Faw
BSF /xcxs	Beresford	Pwn	Pwn	Pwn	Fsw	Faw
BSF /xc1s	Beresford	Pwn	Pwn	Pwn	Fsw	Faw
BSF /xxxt	Beresford	Pwn	Pwn	Pwn	Fsw	Faw
BSF /xc2x	Beresford	Fpt	Fsw	Fwp	Fws	Faw
BSF /xc3x	Beresford	Pp	Fwp	Pp	Fwp	Fap
BSF /xc4x	Beresford	Pp	Pp	Pp	Pp	Pp
CAV	Carvey	Pw	Pw	Pw	Pw	Pw
CBF	Cobfield	Fw	Fw	Fw	Fw	Faw
CBF /xc2x	Cobfield	Fpt	Fsw	Fwp	Fsw	Faw
CBF /xc3x	Cobfield	Pp	Fwp	Pp	Fwp	Fap
CBF /xcxs	Cobfield	Pwn	Pwn	Pwn	Fsw	Faw
CLN	Clementi	Fs	Fs	Fs	Fs	Fa
CLN /xc1x	Clementi	Fst	Fs	Fs	Fs	Fa
CLN /xc2x	Clementi	Fpt	Fs	Fsp	Fs	Fa
CLN /xc3x	Clementi	Pp	Fsp	Pp	Fsp	Fap
CLN /xdxx	Clementi	Pt	Fs	Fs	Fs	Fa
CLN /xd1x	Clementi	Pt	Fs	Fs	Fs	Fa
CLN /1d2x	Clementi	Pt	Fs	Fs	Fs	Fa
CLN /xd4x	Clementi	Ptp	Pp	Pp	Pp	Pp
CLN /xe2x	Clementi	Vt	Fst	Fpt	Fs	Fat
CLN /xe3x	Clementi	Vt	Fpt	Pp	Fsp	Fap
CVA	Cordova	Fs	Fs	Fs	Fs	Fa
CVA /xcxx	Cordova	Fst	Fs	Fs	Fs	Fa
CVA /xd1x	Cordova	Pt	Fs	Fs	Fs	Fa
CXT	Capell	Fsw	Fsw	Fs	Fsw	Faw
CXT /xxxs	Capell	Pwn	Pwn	Pwn	Fsw	Faw
CXW	Chater	Pq	Fs	Fs	G	G
CXW /1c1x	Chater	Pqt	Fs	Fs	G	G
CXW /xc2x	Chater	Pq	Fs	Fp	G	G

TABLE 9. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground (22)	Picnic Area (23)	Camp Area (24)	Path And Trails (25)	Permanent Bldgs. Without Basements (15)
CYN	Croyon	Fs	Fs	Fs	Fs	G
CYN /xc1x	Croyon	Fst	Fs	Fs	Fs	G
CYN /xc2x	Croyon	Fpt	Fs	Fsp	Fs	G
CYN /xdxx	Croyon	Pt	Fs	Fs	Fs	G
CYN /xd2x	Croyon	Pt	Fs	Fsp	Fs	G
CYN /xd4x	Croyon	Ppt	Pp	Pp	Pp	Pp
CYN /xd5x	Croyon	Vp	Vp	Vp	Vp	Pp
DOT	Dorset	Pmq	Fs	Fs	G	G
DOT /xx1x	Dorset	Pmq	Fs	Fs	G	G
DOT /xc1x	Dorset	Pmq	Fs	Fs	G	G
DOT /xc2x	Dorset	Pmq	Fs	Fsp	G	G
DOT /xdxx	Dorset	Pt	Fs	Fs	G	G
DOT /xd1x	Dorset	Pt	Fs	Fs	G	G
DOT /1d1x	Dorset	Pt	Fs	Fs	G	G
DOT /xd2x	Dorset	Pt	Fs	Fsp	G	G
DOT /1e2x	Dorset	Vt	Ft	Ftp	G	Ft
DRO	Drokan	Pw	Pw	Pw	Pw	Pfw
DRO /xx1x	Drokan	Pw	Pw	Pw	Pw	Pfw
DRO /xxxs	Drokan	Pw	Pw	Pw	Pw	Pfw
DRO /xx1s	Drokan	Pw	Pw	Pw	Pw	Pwf
DRO /xx2s	Drokan	Pw	Pw	Pw	Pw	Pwf
DRO /xxxt	Drokan	Pwn	Pwn	Pwn	Pw	Pfw
DXM	Druxman	Fsw	Fsw	Fs	Fsw	Fwa
DXM /xx1x	Druxman	Fsw	Fsw	Fs	Fsw	Fwa
ERX	Eroded Slope Compl	Vt	Vt	Vt	Pt	Vt
JAY	Jaymar	Fsq	Fs	Fs	Fs	Fa
JAY /xc1x	Jaymar	Fst	Fs	Fs	Fs	Fa
JAY /xc2x	Jaymar	Fst	Fs	Fsp	Fs	Fa
JAY /xx3x	Jaymar	Pp	Fsp	Pp	Fsp	Fap
JAY /xc3x	Jaymar	Pp	Fsp	Pp	Fsp	Fap
JAY /xc4x	Jaymar	Pp	Pp	Pp	Pp	Pp
JAY /xc5x	Jaymar	Vp	Vp	Vp	Vp	Pp
JAY /1c2x	Jaymar	Fst	Fs	Fsp	Fs	Fa
JAY /xdxx	Jaymar	Pt	Fs	Fs	Fs	Fa
JAY /1d1x	Jaymar	Pt	Fs	Fs	Fs	Fa
JAY /xd4x	Jaymar	Ptp	Pp	Pp	Pp	Pp
JAY /xd5x	Jaymar	Vp	Vp	Vp	Vp	Pp
LEI	Levine	Fis	Fis	Pi	Fsw	Pi
LEI /xcxx	Levine	Fsi	Fsi	Pi	Fs	Pi
MDN	Marsden	Pw	Pw	Pw	Pw	Pw

TABLE 9. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground (22)	Picnic Area (23)	Camp Area (24)	Path And Trails (25)	Permanent Bldgs. Without Basements (15)
MDN /xxxs	Marsden	Pwn	Pwn	Pwn	Pw	Pw
MDN /xxls	Marsden	Pwn	Pwn	Pwn	Pw	Pw
MDN /xxlt	Marsden	Vwn	Vwn	Vwn	Pw	Pw
MHC	Marsh Complex	Vw	Vw	Vw	Vw	Vw
MRH	Marringhurst	Pmq	Fs	Fs	G	G
MXI	Miniota	Fsq	Fs	Fs	G	G
MXI /xxlx	Miniota	Fsq	Fs	Fs	G	G
MXI /xcxx	Miniota	Fst	Fs	Fs	G	G
MXI /xclx	Miniota	Fts	Fs	Fs	G	G
MXT	Melland	Fws	Fws	Fws	Fws	Fw
MXT /xxlx	Melland	Fws	Fws	Fws	Fws	Fw
MXT /xcxx	Melland	Fwt	Fws	Fws	Fws	Fw
MXT /xclx	Melland	Fwt	Fws	Fws	Fws	Fw
MXT /xxlt	Melland	Pwn	Pwn	Pwn	Fws	Fw
MXT /xc2x	Melland	Fpw	Fws	Fwp	Fws	Fw
MXT /xx2x	Melland	Fpw	Fws	Fwp	Fws	Fw
MXT /xx3x	Melland	Pp	Fwp	Pp	Fwp	Fwp
MXT /xc3x	Melland	Pp	Fwp	Pp	Fwp	Fwp
MXT /xc4x	Melland	Pp	Pp	Pp	Pp	Pp
NDL	Newdale	Fs	Fs	Fs	Fs	Fa
NDL /xcxx	Newdale	Fst	Fs	Fs	Fs	Fa
NDL /xclx	Newdale	Fst	Fs	Fs	Fs	Fa
NDL /lcxx	Newdale	Fst	Fs	Fs	Fs	Fa
NDL /lclx	Newdale	Fst	Fs	Fs	Fs	Fa
NDL /xdxx	Newdale	Pt	Fs	Fs	Fs	Fa
NDL /ldxx	Newdale	Pt	Fs	Fs	Fs	Fa
NDL /xdlx	Newdale	Pt	Fs	Fs	Fs	Fa
NDL /ldlx	Newdale	Pt	Fs	Fs	Fs	Fa
NDL /xd2x	Newdale	Pt	Fs	Fsp	Fs	Fa
NDL /ld2x	Newdale	Pt	Fs	Fsp	Fs	Fa
NDL /2d3x	Newdale	Ptp	Fsp	Pp	Fsp	Fap
PEN	Penrith	Pw	Pw	Pw	Pw	Pw
RUF	Rufford	Fs	Fs	Fs	Fs	Fa
RUF /xdlx	Rufford	Pt	Fs	Fs	Fs	Fa
RUF /ldxx	Rufford	Pt	Fs	Fs	Fs	Fa
RUF /ldlx	Rufford	Pt	Fs	Fs	Fs	Fa
VFF	Vodroff	Pw	Pw	Pw	Pw	Pw
VFF /xxxs	Vodroff	Pwn	Pwn	Pwn	Pw	Pw
VFF /xxls	Vodroff	Pwn	Pwn	Pwn	Pw	Pw
VRC	Varcoe	Fs	Fsw	Fsw	Fsw	Faw

TABLE 9. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground (22)	Picnic Area (23)	Camp Area (24)	Path And Trails (25)	Permanent bldgs. Without Basements (15)
VRC /xcxx	Varcoe	Fst	Fsw	Fsw	Fsw	Faw
VRC /xxxs	Varcoe	Pwn	Pwn	Pwn	Fsw	Faw
VRC /xxls	Varcoe	Pwn	Pwn	Pwn	Fsw	Fwa
VRC /xcxs	Varcoe	Pwn	Pwn	Pwn	Fsw	Faw
VRC /xcls	Varcoe	Pwn	Pw	Pw	Fsw	Fwa
VRC /xx2s	Varcoe	Pwn	Pwn	Pwn	Fsw	Fwa
VRC /xxxt	Varcoe	Pwn	Pwn	Pwn	Fsw	Faw

Appendix A

CORRELATION OF THE SOILS IN THE STUDY AREA RESURVEY WITH THE SOILS OF THE "RECONNAISSANCE SOIL SURVEY OF THE ROSSBURN AND VIRDEN MAP SHEET AREAS" REPORT NO. 6, 1956.

The present detailed resurvey includes selected portions of the former reconnaissance sheets where more detailed soil resource information is required for more intensive land use planning. The Hamiota, Elkhorn, and Rapid City sections lie within the Virden Map Sheet, while the Birtle, Shoal Lake, Newdale and Strathclair portions occur in the Rossburn Sheet. The resurvey benefits from advantages derived from more frequent and intensive examination of soils in the field, use of a larger mapping scale in order to permit delineation of numerous important local soils, use of modern aerial photographs and use of improved methods of studying soils in the laboratory. In particular, changes in the stratigraphy of surface deposits, depth and type of soil profile, degree of erosion, slope, stoniness and salinity are emphasized.

On the reconnaissance maps each unit shown is a compound unit consisting of a complex of soil types known as a "soil association", having a dominant soil type interspersed with related but unlike local soil types in lesser proportion. These associated genetic soil types developed on similar regional parent materials or geological deposits in the same soil zone are designated as a soil association. While soil associations are shown as units on the reconnaissance map, local associated soils, textural classes and phases are occasionally mapped and designated as separate units where areas involved are substantial or where such units are of sufficient local importance. In some instances, such units are identified on the reconnaissance map by site symbols or hatching. The individual associated soils developed on similar kinds of soil parent material are referred to as "soil associates". They are recognized by differences in their soil profile characteristics as a result of differences in topographical position, drainage and associated vegetation.

In the present detailed map of the study area, each unit shown is either a simple unit consisting of a single soil type referred to as a "soil series" or a specifically defined compound unit containing one dominant soil series and usually one other related but unlike soil series associated with it. Soil series in terms of current Canadian Soil Classification criteria (CSSC 1978) are approximately equivalent to soil associates as defined in the former studies. In general, the range in allowable variation in profile characteristics and properties of soil series is significantly less than the range permitted in so-called soil associates.

The detailed resurvey of the areas in this study provides for improved quality and reliability of soil maps for a variety of interpretive applications, including agriculture, engineering and outdoor recreational use. Correlation of the soil series in the resurvey areas with soil associations

and soil associates of the former reconnaissance map sheets is provided in Table 10.

Table 10. Correlation of Soil Series in the Study Area with Soil Associations and Associates of the Rossburn and Virden Map Sheet Areas, Report No. 6, 1956.

Soil Symbol	Soil Name	Subgroup	Corresponding Soil Association and/or Associate Rossburn-Virden Sheet	Remarks
ANL	Angusville	Gleyed Eluviated Black	Newdale, Oxbow	Equivalent to the imperfectly drained Degrading Blackearth-Meadow associate of the Newdale and Oxbow Associations, having a distinct grayish, mottled, "A_2" horizon or Ae.
BKR	Basker	Rego Humic Gleysol	Assiniboine Complex	A significant inclusion in, and the same as the poorly drained Meadow associate of the Assiniboine complex.
BSF	Beresford	Gleyed Rego Black	Beresford	The same as the intermediately drained, Blackearth-Meadow associate of the Beresford Association.
CAV	Carvey	Rego Humic	Marringhurst, Miniota	This series correlates with the poorly drained meadow associate of the Miniota and Marringhurst Associations having a significant loamy textured surface layer overlying sand and gravel.
CBF	Cobfield	Gleyed Black	Beresford	Similar to the Blackearth-Meadow associate of the Beresford Association.
CLN	Clementi	Orthic Black	Beresford	Equivalent to the dominant, well drained Blackearth associate of the Beresford Association.
CVA	Cordova	Calcareous Black	Newdale, Oxbow	The same as the excessively drained, thin Blackearth member of the Oxbow and Newdale Associations.
CXT	Capell	Gleyed Rego Black	Marringhurst, Miniota	The same as the imperfectly drained, Blackearth-Meadow associates of the Marringhurst and Miniota Associations that have a significant surface layer of loamy material overlying sand and gravel.
CXW	Chater	Calcareous Black	Marringhurst, Newdale Modified Oxbow Modified	Similar to the Blackearth member of the Marringhurst Association with a till substrate. A significant inclusion in the Newdale and Oxbow Modified Phase, where sand and gravel wash remains over a till subsoil.
CYN	Croyon	Orthic Black	Marringhurst, Miniota	A significant inclusion in these associations having a heavier loam to clay loam surface texture and equivalent to the Blackearth associate.
DOT	Dorset	Orthic Black	Marringhurst	The same as the dominant, well drained Blackearth member of the Marringhurst Association.

Soil Symbol	Soil Name	Subgroup	Corresponding Soil Association and/or Associate Rossburn-Virden Sheet	Remarks
DRO	Drokan	Rego Humic Gleysol	Newdale, Oxbow	This series is equivalent to the poorly drained, Calcic Meadow associate of the Newdale and Oxbow Associations. The saline phase is equivalent to the Saline Meadow associate.
DXM	Druxman	Gleyed Black	Marringhurst, Miniota	Equivalent to the intermediately drained Blackearth-Meadow associate of the Miniota and Marringhurst Associations having a significant surface mantle of loamy sediments on sand and gravel.
ERX	Eroded Slope Complex	Variable	Eroded Slopes Complex	Equivalent to the Eroded Slopes Complex in the Rossburn-Virden Map. Unchanged.
JAY	Jaymar	Orthic Black	Newdale, Modified Phase, Benchlands Complex, Oxbow Modified	This series is similar to the dominant, well drained, Blackearth associate of the Newdale and Oxbow Modified and Benchlands Complex, having a depositional L-CL surface over an eroded skeletal layer, on till.
LEI	Levine	Gleyed Cumulic Regosol	Assiniboine Complex	A significant inclusion in the Assiniboine Complex. The imperfectly drained, stratified, silty clay loam equivalent.
MDN	Marsden	Rego Humic Gleysol	Newdale Modified Phase, Benchlands Complex, Oxbow Modified	A minor inclusion in and similar to the Meadow associate of the Newdale and Oxbow Modified Phase and the Bechlands Complex. A variable mantle of loamy sediments overlying sand and gravel strata over morainal till.
MIC	Marsh Complex	Rego Gleysol	Organic Soils	The same as the "open marshes" identified under Organic Soils.
MRH	Marringhurst	Orthic Black	Marringhurst	The same as the dominant, well drained Blackearth associate of the Marringhurst Association.
MXI	Miniota	Orthic Black	Miniota	The same as the dominant, well drained, Blackearth associate of the Miniota Association.
MXT	Melland	Gleyed Rego Black	Newdale Modified Phase, Benchlands Complex, Oxbow Modified	Similar to the Calcic Blackearth-Meadow associate of the Newdale and Oxbow Modified, and Benchlands Complex.
NDL	Newdale	Orthic Black	Newdale, Oxbow	Equivalent to the dominant, well drained, Blackearth associate of the Newdale and Oxbow Associations. Although these associations were originally mapped separately on the reconnaissance map based on a slight change in soil climate (Blackearth Zone versus slightly Degrading Blackearth Sub-Zone), today they are grouped under the Newdale Association in the Gt2 Ecoclimatic region.

Soil Symbol	Soil Name	Subgroup	Corresponding Soil Association and/ or Associate Rossburn-Virden Sheet	Remarks
PEN	Penrith	Humic Luvic Gleysol	Newdale, Oxbow	This series is equivalent to the poorly drained Meadow Podzol or degraded Meadow associate of the Newdale and Oxbow Associations.
RUF	Rufford	Rego Black	Newdale, Oxbow	The same as the excessively drained, thin Blackearth member of the Newdale and Oxbow Associations occuring on the knolls and upper slopes.
VFF	Vodroff	Rego Humic Gleysol	Beresford	The Calcic Meadow associate of the Beresford Association. The saline phase is equivalent to the Saline Meadow associate.
VRC	Varcoe	Gleyed Rego Black	Newdale, Oxbow	This series is equivalent to the intermediately drained, Calcic Blackearth-Meadow associate of the Newdale and Oxbow Associations. The saline phase correlates with the salinized associate.

Appendix B

GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES

Table 11. Land Classification Standards for Irrigation Suitability.

Land Characteristics	Subclass		Class 1 - Very Good	Class 2 - Good	Class 3 - Fair	Class 4 - Poor
SOILS	S					
Texture						
very coarse textured		v	Fine sandy loams to clay loams	Loamy fine sand to light clay	Sand to permeable clay	Gravel to clay
very fine textured		h				
Water holding capacity						
low available moisture capacity		q	40 to 60 sat. % >15cm storage in 1.2m <10cm/hr. hydraulic cond.	35 to 65 sat. % >12.5cm storage in 1.2m <12.5cm/hr. hydraulic cond.	25 to 75 sat. % >7.5cm storage in 1.2m <17.5cm/hr. hydraulic cond.	<25 or >75 sat. % <7.5cm storage in 1.2m >17.5cm/hr. hydraulic cond.
Geological Deposit						
shallow deposit over sand or gravel		k	.9m or more of fine sandy loam or heavier	.6m or more of fine sandy loam or heavier, or .75m plus of loamy fine sand or sandy loam	.5m or more of sandy loam or heavier, or .6m plus of loamy sand	<.5m of sandy loam or heavier, or .6m of loamy sand or sand
shallow deposit over impervious substrata		b	>3m of permeable material	>2m of permeable material	>1m of permeable material	<1m of permeable material
Salinity and Alkalinity[1,2]		a	<4 ms/cm in 0-.6m <8 ms/cm below .6m <6 S.A.R.	<4 ms/cm in 0-.6m <12 ms/cm below .6m <8 S.A.R.	<8 ms/cm in 0-.6m <15 ms/cm below .6m <12 S.A.R.	>8 ms/cm in 0-.6m >15 ms/cm below .6m >12 S.A.R.
EXTERNAL FEATURES						
Stones - rock clearing		r	None to light clearing	Light to medium clearing	Light to heavy clearing	Excessively stony
Topography	T	g	<1% and 0.1% in general gradient (0-3% slope)	<3% in general gradient (3-5% slope)	<5% in general gradient (5-10% slope)	>5% in general* gradient (>10% slope)**
Slope						
excess gradient						
DRAINAGE	D					
restricted outlet			No problem anticipated	Moderate drainage problem anticipated but may be improved at relatively low cost	Moderate to severe drainage problem anticipated but may be improved by expensive but feasible measures	Drainage improvement not considered feasible
water table			below 2.4m most of year	could be above 1.5m for a short period, then recedes to 2.4m or lower	within 1.5m most of year	within 1m most of year

* Criteria for gravity (flood) irrigation requirements.

** Estimated adjustments to slope criteria for overhead or sprinkler type irrigation methods.

[1] If sufficient gypsum is present in the soil, the S.A.R. may be lowered by leaching the soil (a very slow process), and the hydraulic conductivity may then improve.

[2] The degree of salinity may vary widely within short distances, and there may be no clear indication of the area occupied by each salinity class. Unless a very detailed mapping and sampling program is carried out, it is impossible to estimate the acreage occupied by each salinity class.

Table 12. Guide for assessing soil suitability as source of topsoil.

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristics of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2/]	Very friable, friable	Loose, firm	Very firm	Cemented
i	Flooding	None	May flood occasionally for short periods	Frequent flooding	Constantly flooded
w	Wetness[2/]	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	Slope	0-5%	5-9%	9-15%	>15%
p	Stoniness[2/]	Stones 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones 0.1 m apart (Class 5)
c	Coarse fragments[2/]: percent, by volume	<3%	3-15%	15-35%	>35%
s	Texture[2/]	FSL, VFSL, L, SiL, SL, SC if 1:1 clay is dominant	CL, SCL, SiCL, SC if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	S, LS, C and SiC if 2:1 clay is dominant. organic soils[3/]	Marl, diatomaceous earth
b	Depth of Topsoil[4/]	>40 cm	15-40 cm	8-15 cm	<8 cm
n	Salinity of Topsoil[5/]	E.C. 0-1	E.C. 1-4	E.C. 4-8	E.C. >8

1/ The symbols are used to indicate the nature of the limitation.

2/ For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Non-woody organic materials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.

4/ The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.

5/ E.C. = Electrical Conductivity (millisiemens/cm).

Table 13. Guide for assessing soil suitability as source of sand and gravel.

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of the soil substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Unified Soil Group	SW SP GW GP	SW-SM SP-SM GP-GM GW-GM	SM SW-SC SP-SC GM GP-GC GW-GC	All other groups and bedrock
h	Depth to Seasonal Water Table	Not class determining if deeper than 50 cm		50 cm	
q	Depth to Sand and Gravel	<25 cm	25-75 cm[2/]	>75 cm[2/]	
p	Stoniness[3/]	Not class determining if stones >.5 m apart (Class 0, 1, 2 and 3)		Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
d	Depth to Bedrock	>100 cm	50-100 cm	<50 cm	

1/ The symbols are used to indicate the nature of the limitation.

2/ Rated good if it is known that the underlying gravel or sand deposit is thick (>100 cm).

3/ For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

Table 14. Guide for assessing soil suitability as source of roadfill.

Fill material for buildings or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. Since surface materials are generally removed during road or building construction their properties are disregarded. Aside from this layer, the whole soil to a depth of 150-200 cm should be evaluated. Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1]	Items Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Subgrade[3]				
	a. AASHO group index[4]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[5] and SC[5]	CL (with P.I.[6] <15) and ML	CL (with P.I.[6] of 15 or more), CH and MH[7]	OL, OH and Pt
l	Shrink-swell potential	Low	Moderate	High	
f	Susceptibility to frost action[8]	Low	Moderate	High	
t	Slope	0-15%	15-30%	30-45%	>45%
p	Stoniness[9]	Stones >2 m apart (Class 0, 1 and 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[9]	Rock exposures >35 m apart and cover <10% of the surface	Rock exposure 10-35 m apart and cover 10-25% of the surface	Rock exposure 3.5-10 m apart and cover 25-50% of the surface	Rock exposures <3.5 m apart and cover 50-90% of the surface
w	Wetness[9]	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanantly wet soils
d	Depth to Bedrock	>100 cm	50-100 cm	20-50 cm	<20 cm
h	Depth to Seasonal Water Table	>150 cm	75-150 cm	50-75 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The first three items pertain to soil after it is placed in a fill; the last six items pertain to soil in its natural condition before excavation for road fill.

3/ This item estimates the strength of the soil material, that is, its ability to withstand applied loads.

4/ Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified soil groups.

5/ Downgrade suitability rating to fair if content of fines is more than about 30 percent.

6/ P.I. means plasticity index.

7/ Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.

8/ Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.

9/ For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

Table 15. Guide for assessing soil suitability for permanent buildings[1]

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corosivity, landscaping and septic tank absorption fields.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	With Basements: Very rapidly, rapidly and well drained. Without Basements: Very rapidly, rapidly, well and moderately well drained.	With Basements: Moderately well drained. Without Basements: Imperfectly drained.	With Basements: Imperfectly, poorly, and very poorly drained. Without Basements: Poorly and very poorly drained.	With Basements: Permanently wet soils. Without Basements: Permanently wet soils.
h	Depth to Seasonal Water Table	With Basements: >150 cm Without Basements: >75 cm	With Basements: 75-150 cm Without Basements: 50-75 cm	With Basements: 25-75 cm Without Basements: 25-50 cm	With Basements: <25 cm Without Basements: <25 cm
i	Flooding	None	None	Occasional flooding (once in 5 years)	Frequent flooding (every year)
t	Slope[5]	0-9%	9-15%	15-30%	>30%
s	Subgrade[6]				
	a. AASHO group index[7]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM and GC and SC	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Potential Frost Action[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones >10 m apart (Class 0 to 1)	Stones 2-10 m apart (Class 2[10])	Stones 0.1-2 m apart (Class 3[10] to 4)	Stones <0.1 m apart (Class 5[10])
r	Rockiness[4],[11]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	With Basements: >150 cm Without Basements: >100 cm	With Basements: 100-150 cm Without Basements: 50-100 cm	With Basements: 50-100 cm Without Basements: <50 cm	With Basements: <50 cm

1/ By halving the slope limits, this table can be used for evaluating soil suitability for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

2/ The symbols are used to indicate the nature of the limitation.

3/ Some soils assessed as fair or poor may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

4/ For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reduce the slope limits by one half for those soils subject to hillside slippage.

6/ This item estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used.

7/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962), pp. 23-25.

8/ P.I. means plasticity index.

9/ Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp. 5-8.

10/ Rate one class better for buildings without basements.

11/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

Table 16. Guide for assessing soil suitability for local roads and streets[1].

This guide applies to soils to be evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime or soil cement stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 meters. Excluded from consideration in this guide are highways designed for fast-moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[3]	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained	Permanently wet soils
i	Flooding	None	Infrequent (once in 5 years)	Occasional (once in 2-4 years)	Frequent (every year)
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Bedrock[4]	>100 cm	50-100 cm	<50 cm	
a	Subgrade[5]				
	a. AASHO group index[6]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[7] and SC[7]	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Susceptibility to Frost Heave[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[3]	Stones >2 m apart (Class 0 to 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[3]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to permit location of roads and streets

1/ These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.

2/ Symbols are used to indicate the nature of the limitation.

3/ For an explanation of stoniness, rockiness and soil drainage classes, see the Canada Soil Information System (Canada Soil Survey Committee, 1978).

4/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.

5/ This item estimates the strength of soil materials as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise, the estimated Unified classes were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.

6/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp. 23-25.

7/ Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.

8/ P.I. means plasticity index.

9/ Frost heave is important where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 5-8.

Table 17. Guide for assessing soil suitability for trench-type sanitary landfills[1/].

The trench-type sanitary landfill is a sanitary landfill, in which dry garbage and trash is buried daily in an open trench and covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G[3/]	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal High Water Table	Not class determining if more than 180 cm		100-180 cm	<100 cm
w	Wetness[4/]	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[5/]	<5 cm/hr	<5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-15%	15-30%	30-45%	>45%
s	Soil Texture[4/],[6/] (dominant to a depth of 150 cm)	SL, L, SiL, SCL	SiCL[7/], CL, SC, LS	SiC, C	Muck, peat, gravel, sand
d	Depth to Hard Bedrock Rippable	>150 cm >150 cm	>150 cm 100-150 cm	100-150 cm 100-150 cm	<100 cm <100 cm
p	Stoniness[4/]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
r	Nature of Bedrock	Impermeable			Highly permeable, fractured, easily soluble

1/ Based on soil depth (120 cm) commonly investigated in making soil surveys.

2/ The symbols are used to indicate the nature of the limitation.

3/ If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".

4/ For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.

6/ Reflects ease of digging and moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.

7/ Soils high in expansive clays may need to be given a suitability rating of poor.

Table 18. Guide for assessing soil suitability for area-type sanitary landfills.

In the area-type sanitary landfill refuse is placed on the surface of the soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material at least 60 cm thick is placed over the fill when it is completed.

The soil under the proposed site should be investigated so as to determine the probability that leachates from the landfill can penetrate the soil and thereby pollute water supplies.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal Water Table[2]	>150 cm	150-100 cm	50-100 cm	<50 cm
w	Wetness[2],[3]	Rapid to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[4],[5]	Not class determining if less than 5 cm/hr		5-15 cm/hr	>15 cm/hr
t	Slope	0-9%	9-15%	15-30%	>30%

1/ The symbols are used to indicate the nature of the limitation.

2/ Reflects influence of wetness on operation of equipment.

3/ For an explanation of drainage, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

4/ Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.

5/ Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor for area-type sanitary landfills.

Table 19. Guide for assessing soil suitability as cover material for area-type sanitary landfills.

The term cover material includes soil materials used to put a daily and final covering layer on refuse in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
s	Texture[2],[3]	SL, L, SiL, SCL	SiCL, CL, SC, LS	SiC, C	Muck, peat, sand, gravel
d	Depth to bedrock[4]	>150 cm	100-150 cm	50-100 cm	<50 cm
c	Coarse fragments[2]	<15%	15-35%	>35%	
p	Stoniness[2]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
t	Slope	<9%	9-15%	15-30%	>30%
w	Wetness[2]	Not class determining if better than poorly drained		Poorly drained	Very poorly drained or permanently wet soils

[1] The symbols are used to indicate the nature of the limitation.

[2] For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.

[4] Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

Table 20. Guide for assessing soil suitability for reservoirs and sewage lagoons.

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage are considered for evaluating soils on their suitability for reservoir and lagoon areas. This evaluation considers soil both as a vessel for the impounded area and as material for the enclosing embankment. As the impounded liquids could be potential sources of contamination of nearby water supplies, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Water Table[2]	>150 cm	100-150 cm	50-100 cm	<50 cm
i	Flooding[3]	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	Soil Permeability	0-0.5 cm/hr	0.5-5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-2%	2-5%	5-9%	>9%
o	Organic Matter	<2%	2-10%	10-30%	>30%
c	Coarse Fragments[4] <25 cm in diameter, % by volume	<20%	20-35%	>35%	
p	Stoniness[4], >25 cm diameter, percent of surface area	<3% (Class 0, 1 and 2)	3-15% (Class 3)	15-50% (Class 4)	>50% (Class 5)
d	Depth to Bedrock[5]	>150 cm	100-150 cm	50-100 cm	<50 cm
j	Thickness of Slowly Permeable Layer	>100 cm	50-100 cm	50-25 cm	<25 cm
a	Subgrade Unified Soil Classes	GC, SC, CL, & CH	GM, ML, SM & MH	SW & SP	OL, OH & Pt GP, GW

1/ The symbols are used to indicate the nature of the limitation.

2/ If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.

3/ Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).

4/ For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Surface exposures of non rippable rock are rated very poor. If underlying bedrock is impermeable, rating should be one class better.

Table 21. Guide for assessing soil suitability for septic tank absorption fields.

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of poor need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	Permeability[2]	Rapid to moderately rapid	Moderate	Slow	Very slow
	Percolation Rate[3] (Auger hole method)	About 8-18 min/cm[3]	18-24 min/cm	Slower than 24 min/cm	
h	Depth to Seasonal Water Table[4]	>150 cm[5]	100-150 cm	50-100 cm	<50 cm
i	Flooding	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Hard Rock, bedrock or other impervious materials	>150 cm	100-150 cm[6]	50-100 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The suitability ratings should be related to the permeability of soil layers at and below depth of the tile line.

3/ Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features. The symbol g is used to indicate this condition. Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.

4/ Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.

5/ A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.

6/ Where the slope is greater than 9%, a depth to bedrock of 100-150 cm is assessed as poor.

Table 22. Guide for assessing soil suitability for playgrounds.

This guide applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.

Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	Occasional flooding. May flood once every 2-3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
t	Slope	0-2%	2-5%	5-9%	>9%
d	Depth to Bedrock	>100 cm	50-100 cm[3]	<50 cm[3]	
c	Coarse fragments on surface[2]	Relatively free of coarse fragments.	<20% coarse fragments.	>20% coarse fragments.	
p	Stoniness[2]	Stones >10 m apart. (Class 0 to 1)	Stones 2-10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones <0.1 m apart. (Class 5)
r	Rockiness[2]	Rock exposures >100 m apart and cover <2% of the surface.	Rock exposures 30-100 m apart and cover about 2-10% of the surface.	Rock exposures <30 m apart and cover >10% of the surface.	Rock outcrops too frequent to permit playground location.
s	Surface Soil Texture[2,4]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C[5]; S, Si	Peaty soils; S and LS subject to blowing.
q	Depth to Sand or Gravel[6]	>100 cm	50-100 cm	<50 cm	
m	Useful Moisture[7]	Water storage capacity[8] >15.0 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).
Coarse fragments for the purpose of this table include gravels and cobbles.

3/ Downgrade to a very poor suitability rating if the slope is greater than 5%.

4/ Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.

5/ Moderately well and well drained SC, SiC and C soils may be rated fair.

6/ Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

7/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8/ Consult glossary for definitions of terms used.

Table 23. Guide for assessing soil suitability for picnic areas.

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water Table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2],[3]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2]	0-20%	20-50%	>50%	
p	Stoniness[2]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[2],[5],[6]	Rock exposures roughly 30-100 or more m apart and cover <10% of the surface.	Rock exposures roughly 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of picnic areas.
m	Useful Moisture[7]	Water storage capacity[8] >15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978). Coarse fragments for the purpose of this table, include gravels and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

3/ Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.

4/ Moderately well and well drained SC, SiC and C soils may be rated fair.

5/ Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

6/ The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

7/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8/ Consult glossary for definitions of terms used.

Table 24. Guide for assessing soil suitability for camp areas.

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but depending on the nature of the facility the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tentsites may allow rock exposures greater than 10 m apart to be considered a slight limitation.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None	Very occasional flooding during season of use. Once in 5-10 years.	Occasional flooding during season of use. Once in 2-4 years.	Flooding during every season of use.
k	Permeability	Very rapid to moderate inclusive.	Moderately slow and slow.	Very slow.	
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2],[3]	SL, FSL, VFSL, L	SiL, SCL, CL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2],[5]	0-20%	20-50%	>50%	
p	Stoniness[2],[6]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2],[6]	No rock exposures	Rock exposures >10 m apart and cover <25% of the area.	Rock exposures <10 m apart and cover >25% of the area.	Rock exposures too frequent to permit campground location.

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[6] Very shallow soils are rated as having a limitation for rockiness and/or stoniness.

Table 25. Guide for assessing soil suitability for paths and trails.

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1]	Items[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Texture[3],[4]	SL, FSL, VFSL, LS, L	SiL, CL, SiCL, SCL	SC, SiC, C[5]; Sand, Si	Peaty soils; loose sand subject to blowing
c	Coarse Fragment Content[4],[6]	0-20%	20-50%	>50%	
p	Stoniness[4]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
w	Wetness[4]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	Rockiness[4],[7]	Rock exposures >30 m apart and cover <10% of the surface.	Rock exposures 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of paths and trails.
t	Slope[8]	0-15%	15-30%	30-60%	>60%
i	Flooding	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

[1] The symbols are used to indicate the nature of the limitation.

[2] The items affecting use listed in this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight affects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines (Epp, 1977).

[3] Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction. Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

[4] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Moderately well and well drained SC, SiC and C soils may be rated fair.

[6] Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

[7] The type of rock outcrop (flat lying vs cliffs), and the orientation of the structure (linear cliffs vs massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

[8] Slope in this context refers to the slope of the ground surface, not the slope of the tread.

Appendix C

GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7. See pH and Reaction, soil.

Alkaline soil - A soil having a pH greater than 7. See Reaction, soil.

Alluvium - A general term for all deposits of rivers and streams.

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occuring under similar climatic conditions but showing different characteristics due to variations in relief and in drainage.

1/3 Atmosphere Moisture - The moisture percentage on dry weight basis of a soil sample that has been air dried, screened, saturated and subjected to a soil moisture tension of 345 cm of water through a permeable membrane for a period of 48 hours. It approximates the soil moisture retention capacity.

Available nutrient - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Available soil moisture - The portion of water in a soil that can be readily absorbed by plant roots: generally considered to be that water held in the soil up to approximately 15 atmospheres pressure.

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals.

Bedrock - The solid rock that underlies soil and regolith or that is exposed at the surface.

Boulders - Stones which are larger than 60 cm in diameter.

Bulk density - The weight of oven dry soil (105 degrees C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

Buried soil - Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in

the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous	6-15%
strongly calcareous	16-25%
v. strongly calcareous	26-40%
extremely calcareous	>40%

Capillary fringe - A zone of essentially saturated soil just above the water table. The size distribution of the pores determines the extent and degree of the capillary fringe.

Carbon-nitrogen ratio (C/N ratio) - The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.

Cation Exchange Capacity (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter: usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

Cobbles - Rock fragments 8 to 25 cm in diameter.

Color - Soil colors are compared with a Munsell color chart. The Munsell system specifies the relative degrees of the three simple variables of color: hue, value and chroma. For example: 10YR 6/4 means a hue of 10YR, a value of 6, and a chroma of 4.

Complex (soil) - A mapping unit used in detailed and reconnaissance soil surveys where two or more soil series that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

Concretions - Hard grains, pellets or nodules from concentration of compounds in the soil that cement soil grains together.

Conductivity, electrical - A physical quantity that measures the readiness with which a medium (irrigation water and soil extracts) transmits electricity. It expresses the concentration of salt in terms of the conductance (reciprocal of the electric resistance in ohms) in millisiemens per cm.

Consistence (soil) - The mutual attraction of the particles in a soil mass, or their resistence to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

Consumptive use factor (CU) - The ratio of consumptive use of water by a crop to potential evapotranspiration. and transpiration. An actively growing crop that completely covers the soil over a large area and that has an ample supply of readily available soil water has a consumptive use factor of 1.0.

Consumptive use of water - The sum of the depths of water transpired by the plants and evaporated from the soil surface and from intercepted precipitation. It may be less or greater than potential evapotranspiration.

Contour - An imaginary line connecting points of equal elevation on the surface of the soil.

Cover - This term generally has one of the following meanings:

1. Vegetation or other material providing protection

2. In forestry, low growing shrubs and herbaceous plants under trees (i.e., ground cover vs. tree cover)

3. Any vegetation producing a protective mat on or just above the soil surface.

Creep (soil) - Slow mass movement of soil and soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and by alternate freezing and thawing.

Decile portion - A one-tenth portion. As used in the soil map symbol A7-B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Delta - A fluvial or glaciofluvial fan shaped deposit at the mouth of a river that empties into a lake or sea.

Deflocculate - To separate or to break up soil aggregates into individual particles by chemical or physical means or both.

Degradation (of soils) - The changing of a soil to a more highly leached and more highly weathered condition, usually accompanied by morphological changes such as the development of an eluviated light colored (Ae) horizon.

Dispersion - Is rated high, moderate or low depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of high indicates that soil aggregates slake readily; a rating of low indicates that aggregates are resistant to dispersion and remain clumped together.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Rapidly drained - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the control section, and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

Imperfectly drained - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups. These soils generally have mottling below the surface layers and generally have duller colors with depth, generally brownish gray with mottles of yellow and gray.

Poorly drained - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Poorly drained soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. These soils have a wide range in available water storage capacity, texture, and depth, and are either Gleysolic or Organic.

Dryland farming - The practice of crop production in low rainfall areas without irrigation.

Eluvial horizon - A horizon from which material has been removed in solution or in water suspension.

Eolian - Soil material accumulated through wind action.

Erosion - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes. The ratings of erosion are:

Erosion 1 slightly eroded - soil with a sufficient amount of the A horizon removed that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer.

Erosion 2 moderately eroded - soil with all of the A horizon and a part of the B or other lower lying horizons removed. The plow layer consists mainly of the original horizons below the A or below the original plow layer.

Erosion 3 severely eroded - soils have practically all of the original surface soil removed. The plow layer consists mainly of C horizon material, especially on knolls and steep upper slope positions.

Evapotranspiration - The combined loss of water from a given area, and during a specific period of time, by evaporation from the soil surface and transpiration from plants.

Field Moisture Equivalent - The minimum moisture content at which a drop of water placed on a smoothed surface of the soil will not be absorbed immediately by the soil, but will spread out over the surface and give it a shiny appearance.

Flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.

Fluvial deposits - All sediments past and present, deposited by flowing water, including glaciofluvial deposits.

Frost heave - The raising of the surface caused by ice in the subsoil.

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Gravel - Rock fragments 2 mm to 7.5 cm in diameter.

Ground Moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till; most till is thought to have accumulated under the ice by lodgment, but some till has been let down from the upper surface of the ice by ablation. Resorting and modification may have taken place to some extent by wave-action of glacial melt waters. The topography is most commonly in the form of undulating plains with gently sloping hills and enclosed depressions.

Groundwater - Water beneath the soil surface, usually under conditions where the voids are completely filled with water (saturation).

Halophytic vegetation - vegetation that grows naturally in soils having a high content of various salts. It usually has fleshy leaves or thorns and resembles desert vegetation.

Horizon (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The form refers to the variation of the boundary plane.

Distinctness -
abrupt - less than 2 cm
clear - 2 to 5 cm
gradual - 5 to 15 cm
diffuse - more than 15 cm

Form -
smooth - nearly plain
wavy - pockets are wider than deep
irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

Humic layer - A layer of highly decomposed organic soil material containing little fibre.

Hydraulic Conductivity - Refers to the effective flow velocity or discharge velocity in soil at unit hydraulic gradient. It is an approximation of the permeability of the soil and is expressed in cm per hour. The classes are described in general or specific terms as:

High	>15	Very rapid	>50
		Rapid	15-50
Medium	0.5-15	Mod. rapid	5.0-15
		Moderate	1.5-5.0
		Mod. slow	0.5-1.5
Low	<0.5	Slow	0.15-0.5
		Very slow	0.015-0.15
		Extremely slow	<.015

Hydrologic cycle - The conditions through which water naturally passes from the time of precipitation until it is returned to the atmosphere by evaporation and is again ready to be precipitated.

Hydrophyte - Plants growing in water or dependent upon wet or saturated soil conditions for growth.

Illuvial horizon - A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

Impeded drainage - A condition that hinders the movement of water by gravity through the soils.

Inclusion - Soil type found within a mapping unit that is not extensive enough to be mapped separately or as part of a complex.

Infiltration - The downward entry of water into the soil

Irrigation - The artificial application of water to the soil for the benefit of growing crops.

Irrigation requirement (IR) - Refers to the amount of water exclusive of effective precipitation that is required for crop production.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landforms - See Description of Landforms

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinquish one part of the earth's surface from another part.

Leaching - The removal from the soil of materials in solution.

Liquid limit (upper plastic limit) - The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. The water content at this boundary is defined as that at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 1.25 cm under the impact of 25 blows in a standard liquid limit apparatus.

Lineal shrinkage - This is the decrease in one dimension expressed as a percentage of the original dimension of the soil mass when the moisture content is reduced from a stipulated percentage (usually field moisture equivalent) to the shrinkage limit.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

Mature soil - A soil having well-developed soil horizons produced by the natural processes of soil formation.

Mesophyte - Plants requiring intermediate moisture conditions and are not very resistant to drought.

Microrelief - Small-scale, local differences in relief including mounds, swales or hollows.

Milliequivalent (me) - One-thousandth of an equivalent. An equivalent is the weight in grams of an ion or compound that combines with or replaces one gram of hydrogen. The atomic or formula weight divided by valence.

Mottles - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottles in soils indicate poor aeration and lack of good drainage.

Organic carbon - Carbon derived from plant and animal residues.

Organic matter - The fraction of the soil which consists of plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. It is determined on soils that have been sieved through a 2.0 mm sieve. It is estimated by multiplying the organic carbon by a factor of 1.72.

Outwash - Sediments "washed out" beyond the glacier by flowing water and laid down in thin beds or strata. Particle size may range from boulders to silt.

Ovendry soil - Soil that has been dried at 105 degrees C until it has reached constant weight.

Parent material - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons. See Textural Triangle at end of Glossary.

The particle-size classes for family groupings are as follows:

Fragmental Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

Loamy-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

Clayey-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

Sandy The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm- 25 cm occupy less than 35% by volume.

Loamy The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm)

or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey. The fine earth contains 35% or more clay by weight and particles 2mm-25 cm occupy less than 35% by volume.

Fine-clayey. A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey. A clayey particle size that has 60% or more clay in the fine earth fraction.

Ped - An individual soil aggregate such as granule, prism or block formed by natural processes (in contrast with a clod which is formed artificially).

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

Percolation - The downward movement of water through soil; specifically, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of 1.0 or less.

Permafrost -

1. Perennially frozen material underlying the solum.

2. A perennially frozen soil horizon.

Permafrost table - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

Permeability - The ease with which water and air pass through the soil to all parts of the profile. See hydraulic conductivity.

pH - The intensity of acidity and alkalinity, expressed as the negative logarithm of the hydrogen ion concentration. A pH of 7 is neutral, lower values indicate acidity and higher values alkalinity (see Reaction, soil).

Phase, soil - A soil phase is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

Plastic Limit - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil.

Plasticity Index - The numerical difference between the liquid and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

Potential evapotranspiration (PE) - The maximum quantity of water capable of being lost as water vapor, in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil - The acidity or alkalinity of a soil. Soil reaction classes are characterized as follows:

extremely acid	pH <4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
mod. alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	>9.0

Regolith - The unconsolidated mantle of weathered rock and soil material on the earth's surface.

Relief - The elevation of inequalities of the land surface when considered collectively.

Runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

Saline Soil - A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millisiemens/cm (ms/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5. Approximate limits of salinity classes are:

non-saline	0 to 4 ms/cm
weakly saline	4 to 8 mS/cm
mod. saline	8 to 15 ms/cm
strongly saline	>15 ms/cm

Salinization - The process of accumulation of salts in the soil.

Salt-Affected Soil - Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium or both.

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation Percentage - The moisture percentage of a saturated soil paste, expressed on an oven dry weight basis.

Seepage -

1. The escape of water downward through the soil.

2. The emergence of water from the soil along an extensive line of surface in contrast to a spring where water emerges from a local spot.

Series, soil - A category in the Canadian System of Soil Classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, except for surface tex-

ture and are formed from a particular type of parent material.

Shrinkage limit - This is the moisture content at which an equilibrium condition of volume change is reached and further reduction in moisture content will not cause a decrease in the volume of the soil mass.

Shrinkage ratio - This is the ratio between the volume change and a corresponding change in moisture content. It equals the apparent specific gravity of the dried soil.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Slickenside - Smoothed surfaces along planes of weakness resulting from the movement of one mass of soil against another in soils dominated by swelling clays.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with other cations in the soil SAR = $Na/((Ca+Mg)/2)^{1/2}$ where the cation concentrations are expressed as milliequivalents per litre.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Stones - Rock fragments greater than 25 cm in diameter.

Stoniness - The percentage of land surface occupied by stones. The classes of stoniness are defined as follows:

Stones 0. Nonstony -- Land having less than 0.01% of surface occupied by stones.

Stones 1. Slightly stony -- Land having 0.01-0.1% of surface occupied by stones. Stones 15-30 cm in diameter, 10-30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. Moderately stony -- Land having 0.1-3% of surface occupied by stones. Stones 15-30 cm in diameter, 2-10 m apart. Stones cause some interference with cultivation.

Stones 3. Very stony -- Land having 3-15% of surface occupied by stones. Stones 15-30 cm in diameter, 1-2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. Exceedingly stony -- Land having 15-50% of surface occupied by stones. Stones 15-30 cm in diameter, 0.7-1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. Excessively stony -- Land having more than 50% of surface occupied by stones. Stones 15-30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation.

Storage Capacity - Refers to the maximum amount of readily available water that can be stored within the rooting zone of a crop in a given soil. For practical irrigation purposes, 50 percent of the total soil water between field capacity and wilting point may be considered as readily available.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers. In stratified materials, a bed is a unit layer distinctly separable from other layers and is one or more cm thick but a lamina is a similar layer less than 1 cm thick.

Structure - The combination or arrangement of primary soil particles into aggregates of secondary soil particles, units or peds, which are separated from each other by surfaces of weakness. Structure is expressed in terms of grade, size class and shape type. Grade refers to the distinctness of aggregate development, and is described as structureless, weak, moderate or strong. Structureless refers to the absence of observable aggregation of definite orderly arrangement; the term amorphous is used if soil is massive or coherent, single-grained if noncoherent. The weak to strong aggregates vary in size and are described by class as fine, medium, coarse, and very coarse depending on the shape types. The shape types refers to the dominant configuration of the aggregates and the way they are accommodated. The general shape types are plate-like, block-like and prism-like. The terms are:

Platy - Having thin, plate-like aggregates with faces mostly horizontal

Prismatic - Having prism-like aggregates with tops and edges, appear plane, level and somewhat angular.

Columnar - Having prism-like aggregates with vertical edges near the top of columns, not sharp.

Granular - Having block-like aggregates that appear as spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of the surrounding peds.

Blocky - Having block-like aggregates with sharp, angular corners

Subangular blocky - Having block-like aggregates with rounded and flattened faces and rounded corners.

By convention an aggregate is described in the order of grade, class and type, e.g. strong, medium, blocky. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Sulfate Hazard - Refers to the relative degree of attack on concrete by soil and water containing various amounts of sulfate ions. It is estimated from electrolyte measurements and salt analysis on selected profiles and soil samples, and by visual examination of free gypsum within the profile during the course of soil investigation.

Swamp - See Description of Landforms

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons. See Texture Triangle at end of Glossary.

The size range of the constituent primary particles are as follows:

	Diameter (mm)
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	< 0.002
Fine clay	< 0.0002

Till, glacial - Unstratified glacial deposits consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergency and root penetration.

Topography - Refers to the percent slope and the pattern or frequency of slopes in different directions. A set of 10 slope classes are used to denote the dominant but not necessarily most abundant slopes within a mapping unit.

Slope Class	Slope Name	Percent slope	Approx. degrees
1	level	0-0.5	0
2	nearly level	.5-2.5	.3-1.5
3	very gentle	2-5	1-3
4	gentle	6-9	3.5-5
5	moderate	10-15	6-8.5
6	strong	16-30	9-17
7	very strong	31-45	17-24
8	extreme	46-70	25-35
9	steep	71-100	35-45
10	very steep	>100	>45

Underground runoff - (or seepage)-Water flowing towards stream channels after infiltration into the ground.

Unified Soil Classification System (engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Urban Land - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.

Variant, soil - A soil whose properties are believed to be sufficiently different from other known soils to justify a new series name, but comprising such a limited geographic area that creation of a new series is not justified.

Varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light colored layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark colored layer of clay laid down in the fall and winter.

Water balance, soil - Is the daily amount of readily available water retained by the soil. The daily soil-water balance is decreased by the amount that the daily consumptive use exceeds the daily rainfall. When daily rainfall exceeds the consumptive use, the daily balance increases by the amount of the difference unless the soil-water balance is at storage capacity, in which case the excess is assumed to be lost by runoff or deep percolation.

Water table - (groundwater surface; free water surface; groundwater elevation) Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

Water-holding capacity - The ability of a soil to hold water against the force of gravity in a freely drained soil.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Xerophyte - Plants capable of surviving extended periods of soil drought.

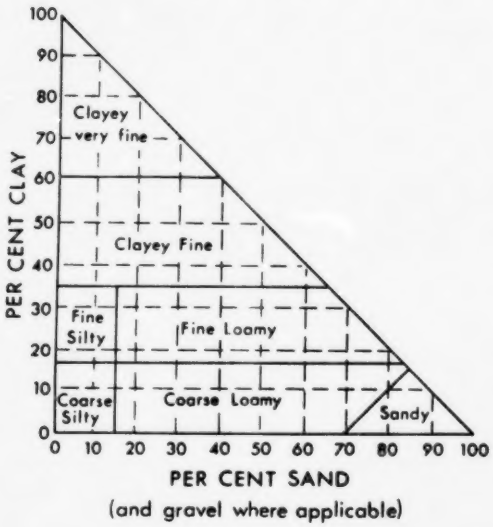
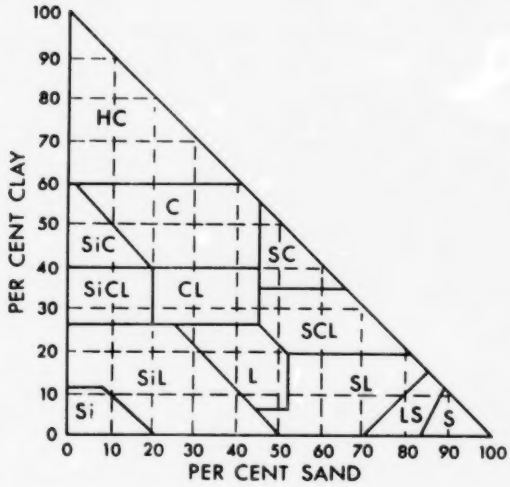


Figure 6: Family particle-size classes.



Texture Group	Class Symbol	Class Name
Coarse	S	sand
	LS	loamy sand
Moderately coarse	SL	sandy loam
	LVFS	loamy very fine sand
Medium	Si	silt
	SiL	silt loam
	L	loam
	VFSL	very fine sandy loam
Moderately fine	SCL	sandy clay loam
	CL	clay loam
	SiCL	silty clay loam
Fine	SC	sandy clay
	C	clay
	SiC	silty clay
Very fine	HC	heavy clay

Figure 7: Soil Textural Classes.

Appendix D

SOIL HORIZON DESIGNATIONS

ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

O This is an organic horizon developed mainly from mosses, rushes, and woody materials.

Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.

Om The mesic horizon is the intermediate stage of decompostion with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or humic.

Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

H This is an organic horizon characterized by an accumulation of decomposed organic

matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

MASTER MINERAL HORIZONS

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizons.

A This is a mineral horizon or horizons formed at or near the surface in the zone of leaching or removal of materials in solution and suspension or of maximum in situ accumulation of organic matter, or both. Included are:

1. horizons in which organic matter has accumulated as a result of biological activity (Ah);

2. horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of them (Ae);

3. horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);

4. horizons markedly disturbed by cultivation or pasture (Ap).

B This is a mineral horizon or horizons characterized by one or more of the following:

1. an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt,Bf,Bfh,Bhf, and Bh);

2. a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amount of exchangeable Na (Bn);

3. an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm,Bg).

C This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca,Csa,Cg, and C). Marl and diatomaceous earth are considered to be C horizons.

R This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist and that does not meet the requirement of a C horizon. The boundary between the R layer and overlying unconsolidated material is called a lithic contact.

W This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils.

LOWER-CASE SUFFIXES

b Buried soil horizon.

c A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, and a layer cemented by calcium carbonate and a duripan are examples.

ca A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10 cm thick, and if it has a $CaCO_3$ equivalent of less than 15 percent it should have at least 5 percent more $CaCO_3$ equivalent than the parent material (IC). If it has more than 15 percent $CaCO_3$ equivalent it should have 1/3 more $CaCO_3$ equivalent than the IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms.

cc Cemented (irreversible) pedogenic concretions.

e A horizon characterized by the eluviation of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).

f A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.002mm) is more than 0.05 and organic C exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of organic C to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. The following horizons are differentiated on the basis of organic carbon content: Bf - 0.5% to 5% organic carbon. Bhf-more than 5% organic carbon.

g A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

Aeg This horizon must meet the definitions of A,e, and g.

Bg These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are lacking; or chromas of 2 or less in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by more promi-

nent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols.

Bfg, Bhfg, Btg, and others. When used in any of these combinations the limits set for f, hf, t, and others must be met.

Bgf The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag. When g is used with C alone, or with C and one of the lower-case suffixes k, ca, s, or sa, it must meet the definition for C and for the particular suffix.

h A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).

Ah A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.

Ahe An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter-colored Ae.

Bh This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of organic carbon to pyrophosphate-extractable Fe of 20 or more. Generally the color value and chroma are less than 3 when moist.

Bhf Defined under 'f'.

j Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies. For example Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features.

Aej It denotes an eluvial horizon that is thin, discontinuous or slightly discernible.

Btj It is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj. Horizons that are mottled but do not meet the criteria of Bg.

Bfj It is a horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf.

Bntj or Bnj. Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt.

k Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk).

m A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:

1. Evidence of alteration in one of the following forms:

   a) Higher chromas and redder hues than the underlying horizons.

   b) Removal of carbonates, either partially (Bmk) or completely (Bm).

2. Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.

3. Some weatherable minerals.

4. No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

n A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt.

p A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O.

s A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any horizon or combination of horizon and lowercase suffix.

sa A horizon with secondary enrich-

ment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 ms/cm and must exceed that of the C horizon by at least one-third.

t An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc.

Bt A Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:

   a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2mm) the Bt horizon must contain at least 3% more clay, e.g.,Ae 10% clay-Bt minimum 13% clay.

   b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.

   c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g. Ae 50% clay; Bt at least 58% clay.

2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.

3. In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.

4. If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.

5. If a soil shows a lithologic discontinuity between the eluvial

horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

Btj, Btj, and Btg are defined under j and g.

u A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc. must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g. Aeu, Bfu, BCu.

x A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water.

y A horizon affected by cryoturbation as manifested by disrupted and broken horizons,, incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g. Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc.

z A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

Appendix E

DESCRIPTION OF LANDFORMS

E.1 GENETIC MATERIALS

Unconsolidated mineral component

The unconsolidated mineral component consists of clastic sediments that may or may not be stratified, but whose particles are not cemented together. They are essentially of glacial or post-glacial origin but include poorly consolidated and weathered bedrock.

Anthropogenic - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.

Colluvial - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement.

They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches).

Eolian - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

These materials have been transported and deposited by wind action.

Fluvial - Sediment generally consisting of gravel and sand with a minor fraction of silt and clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification, but massive, nonsorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. Finer textured Fluvial deposits of modern rivers are termed Alluvium.

Lacustrine - Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action.

These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action.

Marine - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have

accumulated at their margins through shoreline processes such as wave action and longshore drift.

Morainal - Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Saprolite - Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering.

The rock remains in a coherent state, interstitial grain relationships are undisturbed and no downhill movement due to gravity has occurred.

Undifferentiated - A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment.

Volcanic - Unconsolidated pyroclastic sediments. These include volcanic dust, ash, cinders, and pumice.

Qualifying Descriptors

These have been introduced to qualify the genetic materials and to supply additional information about the mode of formation or depositional environment.

Glacial - Used to qualify nonglacial genetic materials or process modifiers where there is direct evidence that glacier ice exerted a strong but secondary or indirect control upon the mode of origin of the materials or mode of operation of the process. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material or the site of operation of a process.

Glaciofluvial - Fluvial materials showing clear evidence of having been deposited either directly in front of or in contact with glacier ice.

Glaciolacustrine - Lacustrine materials deposited in contact with glacial ice.

Glaciomarine - Materials of glacial origin laid down in a marine environment, as a result of settling from melting, floating ice and ice shelves.

Organic component

The organic component consists of peat deposits containing >30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick. The classes and their definitions follow.

B	Bog
N	Fen
S	Swamp

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Fen - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Swamp - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

E.2 GENETIC MATERIAL MODIFIERS

Material modifiers are used to qualify unconsolidated mineral and organic deposits. Particle-size classes serve to indicate the size, roundness, and sorting of unconsolidated mineral deposits. Fiber classes indicate the degree of decomposition and fiber size of organic materials.

Particle size classes for unconsolidated mineral materials

Blocky: An accumulation of angular particles greater than 256 mm in size.

Bouldery: An accumulation of rounded particles greater than 256 mm in size.

Clayey: An accumulation of particles where the fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Cobbly: An accumulation of rounded particles having a diameter of 64-256 mm.

Gravelly: An accumulation of rounded particles ranging in size from pebbles to boulders.

Loamy: An accumulation of particles of which fine earth fraction contains 35% or less clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Pebbly: An accumulation of rounded particles having a diameter of 2-64 mm.

Rubbly: An accumulation of angular fragments having a diameter of 2-256 mm.

Sandy: An accumulation of particles of which the fine earth fraction contains more than 70% by weight of fine sand or coarser particles. Particles greater than 2 mm occupy less than 35% by volume.

Silty: An accumulation of particles of which the fine earth fraction contains less than 15% of fine sand or coarser particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.

Fiber classes for organic materials

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric: The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

Mesic: Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.

Humic: Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.

Woody: Organic material containing more than 50% of woody fibers.

E.3 SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Consolidated and Unconsolidated mineral surface classes

Apron - A relatively gentle slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.

Blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.

Fan - A fan-shaped form similar to the segment of a cone and having a perceptible gradient from the apex to the toe.

Hummocky - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35 degrees).

Inclined - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35 degrees). The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Level - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1 degree).

Rolling - A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wave-lake pattern of moderate relief. Slope length is often 1.6 km or

greater and gradients are greater than 5% (3 degrees).

Ridged - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.

Steep - Erosional slopes, greater than 70% (35 degrees), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.

Terraced - Scarp face and the horizontal or gently inclined surface (tread) above it.

Undulating - A very regular sequence of gentle slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3 degrees).

Veneer - Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the material's genesis.

Organic surface classes

Blanket - A mantle of organic materials that is thick enough to mask minor irregularities in the underlying unit but still conforms to the general underlying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 cm-1m) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

NDL MANITOBA 1985 PROFILE

IDENTIFICATION: SURVEYED BY GP, FOR THE PURPOSE OF DETAILED SURVEY; PROVINCIAL SOIL SURVEY, WINNIPEG,MAN. STATUS: MODAL; EXTENSIVE.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC BLACK. MINERAL SOIL FAMILY: FINE LOAMY, MIXED NONCLAY, ALKALINE, EXTREMELY CALCAREOUS, COOL, SUBHUMID. SOIL MAP UNIT: TAXONOMIC SERIES, NOTATION: NDL, ASSOCIATED SOILS: VRCAND PEN. SOIL PHASES: VERY GENTLY SLOPING AND GENTLY SLOPING AND SLIGHTLY ERODED AND NONSTONY AND SLIGHTLY STONY AND NONROCKY.

LOCATION: MILITARY GRID REF. 14 ULL 8760 9010; NTS MAP AREA 62K 7; SE 16 17 23 W.

VEGETATION: CROPS-FIELD (MANAGED). WHEAT FIELD.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL AND MODERATE CHEMICAL WEATHERING, FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), MORAINAL (TILL), MIXED; LANDFORM CLASSIFICATION: MORAINAL, LOAMY, UNDULATING; SLOPE: 4% SLOPE OF CLASS 3 (2-5%), FACING SOUTHEAST, SITE AT UPPER SLOPE POSITION, LEVEL MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: SUBHUMID, WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SLIGHT WATER EROSION; NONSTONY AND SLIGHTLY STONY; NONROCKY; PRESENT LAND USE: CROPLAND.

AP: 0 TO 15 CM, RANGE 12 TO 16 CM; HORIZON MOIST; MATRIX MOIST 10YR 2.5/1, MATRIX DRY 10YR 3.5/1; CLAY LOAM; VERY WEAK, COARSE, SUBANGULAR BLOCKY STRUCTURE; MODERATE TO STRONG, FINE TO MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE; STICKY, FIRM, PLASTIC CONSISTENCE; SLIGHTLY POROUS; SMOOTH, CLEAR HORIZON BOUNDARY.

BMTJ: 15 TO 32 CM, RANGE 15 TO 18 CM; HORIZON MOIST; MATRIX MOIST 10YR 3.5/3.5, MATRIX DRY 10YR 5/3.5; GRITTY CLAY LOAM; MODERATE TO STRONG, MEDIUM, SUBANGULAR BLOCKY STRUCTURE PSEUDO; MODERATE TO STRONG, FINE TO MEDIUM, GRANULAR SECONDARY STRUCTURE PSEUDO; STICKY, FRIABLE, PLASTIC AND VERY PLASTIC CONSISTENCE; MODERATELY POROUS; 10% GRAVELLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CCA: 32 TO 60 CM, RANGE 25 TO 30 CM; HORIZON MOIST; MATRIX MOIST 10YR 5.5/3, MATRIX DRY 10YR 7/3.5; GRITTY SILTY CLAY LOAM; FEW, FINE, FAINT MOTTLES; WEAK, MEDIUM, ANGULAR BLOCKY STRUCTURE PSEUDO; MODERATE TO STRONG, FINE TO MEDIUM, GRANULAR SECONDARY STRUCTURE PSEUDO; STICKY, FRIABLE, PLASTIC CONSISTENCE; MODERATELY POROUS; MODERATE AND STRONG EFFERVESCENCE; STRONGLY CALCAREOUS AND VERY STRONGLY CALCAREOUS; HOMOGENEOUS BANDED ; 10% GRAVELLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

CK: 60 TO 100 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 5/4, MATRIX DRY 2.5Y 6/3; GRITTY CLAY LOAM; COMMON, FINE AND MEDIUM, PROMINENT, 10YR 5/6 MOTTLES; MODERATE, MEDIUM TO COARSE, ANGULAR BLOCKY STRUCTURE PSEUDO; MODERATE, MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; STICKY, FIRM, PLASTIC CONSISTENCE; SLIGHTLY POROUS AND MODERATELY POROUS; LIME AND IRON-MANGANESE CONCRETIONS LOCATED ; MODERATE EFFERVESCENCE; STRONGLY CALCAREOUS; NONHOMOGENEOUS AND STREAKED AND SPOTTED ; 10% AND 20% GRAVELLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	TOTAL N (%)	CALC CARB EQU.%	CAL-CITE (%)	DOLO-MITE (%)	EXTR ACID	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
AP	7.6	3.02	0.27	1.8	0.9	0.8	1.8	33.4		26.4	4.3	0.1	0.8
BMTJ	7.6	0.46	0.06	0.8			1.0	23.5		15.6	5.9	0.1	0.6
CCA	7.8			20.1	12.1	7.3		21.4		27.9	8.2	0.2	0.4
CK	7.9			16.7	9.4	6.7		21.7		26.1	13.1	0.4	0.4

NDL MANITOBA 1985 PROFILE

CHEMICAL DATA (SURVEY)

HORIZON	ELEC COND (MMHOS/CM)	% H2O AT SATUR
AP	0.4	54.5
BMTJ	0.3	44.8
CCA	0.4	48.4
CK	0.4	49.0

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS													
	% PASSING				% OF SAMPLE									
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
AP				98	2	5	8	10	10	35		34	31	
BMTJ				99	2	4	9	12	9	36		31	33	
CCA				99	1	3	4	5	5	18		53	29	
CK			98	97	3	4	7	9	8	31		39	30	

PHYSICAL DATA

SURVEY (CON'T)

MOISTURE STATUS (%)

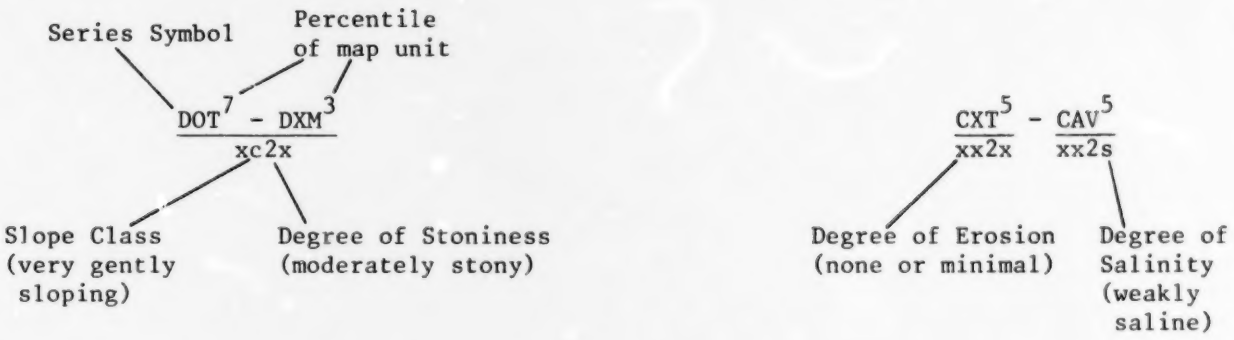
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST
AP			12.8		
BMTJ			10.7		
CCA			11.4		
CK			12.9		

Soil Legend for WESTERN TOWNS

Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
ANL	Angusville	L-CL	IMPER	Till	Fine Loamy	GLE.BL
BKR	Basker	SICL	POOR	Fluvial	Loamy	R.HG
BSF	Beresford	CL	IMPER	Lacustrine/Till	Loamy	GLR.BL
CAV	Carvey	CL	POOR	Lacustrine/Fluvial	Loamy/Sandy Skeletal	R.HG
CBF	Cobfield	CL	IMPER	Lacustrine/Till	Loamy	GL.BL
CLN	Clementi	CL	WELL	Lacustrine/Till	Loamy	O.BL
CVA	Cordova	L-CL	WELL	Till	Fine Loamy	CA.BL
CXT	Capell	CL	IMPER	Lacustrine/Fluvial	Fine Loamy/Sandy Skeletal	GLR.BL
CXW	Chater	Gr.S	WELL	Fluvial/Till	Sandy Skeletal/Loamy	CA.BL
CYN	Croyon	L-CL	WELL	Lacustrine/Fluvial	Loamy/Sandy Skeletal	O.BL
DOT	Dorset	LS	WELL	Fluvial	Sandy Skeletal	O.BL
DRO	Drokan	CL	POOR	Till	Fine Loamy	R.HG
DXM	Druxman	L-CL	IMPER	Lacustrine/Fluvial	Loamy/Sandy Skeletal	GL.BL
ERX	Eroded Slope Complex	Var.	WELL-IMP	Variable	Variable	
JAY	Jaymar	L	WELL	Fluviolacustrine/Till	Loamy	O.BL
LEI	Levine	SICL	IMPER	Fluvial	Loamy	GLCU.R
MDN	Marsden	L	POOR	Fluviolacustrine/Till	Loamy	R.HG
MHC	Marsh Complex	L	V.POOR	Organic	Textural Complex	R.G
MRH	Marringhurst	LS	WELL	Fluvial	Sandy Skeletal	CA.BL
MXI	Miniota	SL	WELL	Lacustrine/Fluvial	Coarse Loamy/Sandy Skeletal	O.BL
MXT	Melland	L	IMPER	Fluviolacustrine/Till	Loamy	GLR.BL
NDL	Newdale	L-CL	WELL	Till	Fine Loamy	O.BL
PEN	Penrith	L-CL	POOR	Till	Fine Loamy	HU.LG
RUF	Rufford	L-CL	WELL	Till	Fine Loamy	R.BL
VFF	Vodroff	CL	POOR	Lacustrine/Till	Loamy	R.HG
VRC	Varcoe	CL-L	IMPER	Till	Fine Loamy	GLR.BL

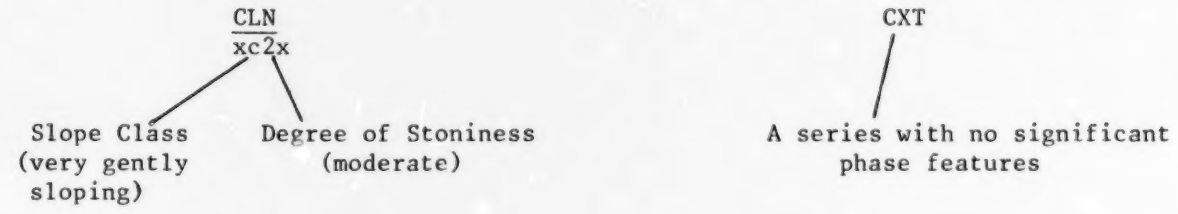
MAP UNIT SYMBOLOGY

Compound Map Units


Series Symbol
Percentile of map unit
DOT 7 - DXM 3
xc2x
Slope Class (very gently sloping)
Degree of Stoniness (moderately stony)
CXT 5 - CAV 5
xx2x xx2s
Degree of Erosion (none or minimal)
Degree of Salinity (weakly saline)

In a compound unit where two series share the same denominator, the phases apply to both series accordingly.

Simple Map Units



Phases

Degree of Erosion

x	non-eroded or minimal
1	slightly eroded
2	moderately eroded
3	severely eroded
o	overblown

Slope Class

x	0-2%	level to nearly level
c	3-5%	very gently sloping
d	6-9%	gently sloping
e	10-15%	moderately sloping
f	16-30%	strongly sloping
g	31-45%	very strongly sloping
h	46-70%	extremely sloping

Stoniness

x	non-stony
1	slightly stony
2	moderately stony
3	very stony
4	exceedingly stony
5	excessively stony

Degree of Salinity

		Cond. mS/cm
x	non-saline	0-4
s	weakly saline	5-8
t	moderately saline	9-15
u	strongly saline	16+